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PRACTICAL SANITATION.

PRACTICAL SANITATION:

A Handbook for Sanitary Inspectors and others interested in Sanitation.

BY

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PREFACE TO TWENTIETH EDITION.

For the purpose of this edition the text has been revised and brought up-to-date.

As regards the Appendix on Sanitary Law, it is to be regretted that the long-expected codification of the many Acts of Parliament which govern procedure has not yet been effected.

G. R.

June, 1921.

PREFACE TO FIRST EDITION.

The question of sanitation is one which is now attracting the serious attention of the general public. People are beginning to enquire for themselves into matters which, hitherto, they have closed their eyes to. The necessity for no longer allowing grave sanitary defects to exist in our houses and their surroundings is now generally acknowledged, and this has led to a demand that plumbers shall possess a sound knowledge of their work. The action of the Sanitary Institute in encouraging a desire on the part of Inspectors of Nuisances, or as I generally designate them in this book, Sanitary Inspectors, to acquire a practical and scientific knowledge of their duties, supported in many instances by Sanitary Authorities, who make it a condition that such Officers shall hold a certificate of qualification, has greatly helped on the cause of Sanitation.

In the autumn of 1890 I delivered a course of lectures on Sanitation, in Stafford, under the auspices of the County Council. The course was principally intended for Sanitary Inspectors in the county, but others, including Members of Local Authorities, builders, plumbers, and a section of the general public interested in the subject, availed themselves of the invitation to attend.

This lecture scheme attracted the attention of the Sanitary Institute, who, the following year, in conjunction with the County

Council, organised a second course of lectures in Stafford, the lecturers being well-known specialists. At the termination of this course, an open examination was held at Stafford by the Sanitary Institute, for which, in addition to candidates from other parts of England and Scotland, twenty-five Staffordshire Inspectors entered; of these, twenty-three satisfied the examiners, and obtained the certificate of the Institute,—by far the largest percentage of passes that had been recorded since the institution of the Examination about ten years ago.

Hitherto, such Lectures have been delivered in London only, but, recently, the example set by Staffordshire has been followed in other counties and towns, for example, Derbyshire, the West Riding of Yorkshire, Cardiff, and Newcastle-on-Tyne, and it is likely that the movement will extend still further.

On the termination of the first Course of Lectures, I was requested by those who attended the Class to publish them, but this I could not do, as they had been delivered from notes only. It occurred to me, however, that a Hand-Book on Practical Sanitation, arranged specially for Sanitary Inspectors and others engaged in the work, although written in a form which would be useful to the general reader, and, possibly, to Students of Technical Instruction Classes, would fill what would appear to be a vacant corner in the literature of the subject

With this object I have compiled these pages, which include descriptions of insanitary as well as sanitary work and appliances, illustrated by numerous diagrams.

As the end for which sanitary appliances are designed may be entirely defeated through the ignorance or culpability of the workmen employed in fixing them, attention has been paid to the details of plumbing and drainage work,—sufficient,

it is hoped, to enable Sanitary Inspectors to recognise faulty work, and appreciate the dangers that may arise from it.

The subjects of Sanitary Law, Model Bye-laws, and other matters which are not of such general interest, are introduced in the form of an Appendix, with a view more especially to meeting the wants of the Sanitary Inspector. This Appendix also deals with the duties of Sanitary Inspectors and their relations to the Sanitary Authority and the general public.

G. R.

STAFFORD, *June*, 1892.

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PRACTICAL SANITATION.

CHAPTER I.

INTRODUCTORY.

Before discussing the details of sanitary work, time will not be wasted if we take a brief glance at the past history of sanitary science or Hygiene.

According to the late Prof. Parkes, hygiene is a science which aims at rendering growth more perfect, decay less rapid, life more vigorous, and death more remote. Our conditions of life are unnatural. Commerce brings us together into densely populated areas, too small to admit of cleanly surroundings; by reason of this, we breathe unwholesome air, and drink contaminated water; our food, either from our poverty or over indulgence, is not fitted for our requirements; vice and drink play their parts in the production of disease; and all these combined have resulted in the transmission of enfeebled constitutions less able to withstand the hardships to which they are exposed.

To correct the defects of our surroundings and habits is the aim of hygiene, and although it may not be possible, owing to the necessities of the times in which we live, to arrive at an ideal state of existence, much may be done, as indeed much has been done, towards that end, and, in time, the influence of heredity, which, through our own faults, has hitherto told in a deleterious direction, will act as an all-powerful ally in improving the stamina of the race.

In recent years more especially, the attention of eminent scientists has been devoted to the study of hygiene in its various

branches. Our knowledge regarding the nature of contagion, for example, has thus advanced by leaps and bounds, and this has led to greater precision in the measures adopted to combat it. Where formerly we were groping in the dark and guessing at conclusions, we are now able to work on more or less definite lines. Again, improved methods of compiling and studying vital statistics, combined with a better knowledge of disease generally, have been instrumental in the advancement of sanitary legislation; yet, notwithstanding the evidence in favour of this, there are people still to be found who ask "what good has all this done;" it may be well, therefore, to review the past, and see what light history can throw upon the question. Most people are aware that to filth, in the broad sense of the term, must be attributed the pestilence and death of the dark ages, when whole armies were destroyed, when cities were depopulated, when gaols were death holes, and when the general annual death-rate exceeded 80 per 1,000.

In 1844, the Health of Towns Commission, which had been appointed mainly owing to the energy and work of Mr. Chadwick, Dr. Farr, and others, presented their report, and four years later, owing to a cholera scare, the Public Health Act of 1848 was passed.

By this Act, power was given to local authorities to borrow money for sanitary purposes, but in it, as in many of the Acts that followed, the word *may* too often took the place of *shall;* in fact, its adoption was optional in place of being compulsory. In this instance it was perhaps a fortunate circumstance that it was so, for, in those days, architects and engineers did not know their work, and in place of the surface channels then generally to be found, badly constructed and ill ventilated sewers were laid down, which were directly connected by untrapped and unventilated drains with the houses. Much of this work is to be found at the present time, and, had we but a portion of the money that was thus originally misspent, as well as what has since been expended in correcting these mistakes, we might well afford to place every district in the Kingdom in thorough sanitary order. No real progress was made until Urban and Rural Authorities were established by the Public Health Act of 1872.

The Privy Council still remained the central Authority, but in 1875 an improved Act was passed—the last general Public Health Act—by which the control of sanitary affairs was transferred to the Local Government Board.

It is sometimes said that figures may be made to prove any-

thing, but the following plain statement tells an unmistakable tale, to whatever causes the improvement may be attributed :—

TABLE SHOWING PROGRESSIVE IMPROVEMENT IN DEATH-RATE.

	Period of Years.	Mean Annual Death-rate per 1,000 living.
	Ten years, 1862-71,	22·6
Public Health Act, 1872, .	Four years, 1871-75,	21·9
„ „ 1875, .	Five years, 1876-80,	20·8
	„ 1881-85,	19·4
	„ 1886-90,	18·9
	„ 1891-95,	18·7
	„ 1896-1900,	17·6
	„ 1901-1905,	16·0
	„ 1906-1910,	14·6
	„ 1911-1915,	14·3

This table speaks for itself. Starting with an average death-rate, per 1,000 of the population, of 22·6 for the ten years ending 1871, it falls to 21·9 for the four years subsequent to the passing of the 1872 Act, to 20·8 for the five years' period following the passing of the 1875 Act, and so on, step by step, until the figure 14·3 is recorded for the five years' period ending 1915. This is the picture when viewed from the broad standpoint of general results, but let us go a step farther and see whether, and to what extent, we can particularise as regards cause and effect. In the year 1866, Dr. Buchanan conducted an enquiry, with a view to discovering whether any benefit to health had followed the carrying out of sanitary works in certain districts. The places selected were those in which the improvements had been longest established, and this was the only consideration that influenced the selection. In the following table the results are given as regards the general mortality, and as regards the mortality from typhoid fever and phthisis, diseases that are well-known to be influenced by sanitary surroundings.

It is not always possible in sanitary work to demonstrate that good results follow each individual act of improvement, and the public are slow to recognise the broad fact that they derive a very substantial return for the money expended in this direction; yet from the above tables there can be no doubt that the death-rate has steadily decreased in recent years; and when we con-

sider that for each life saved there is also a saving of many weeks of sickness, the financial gain to the community must be enormous.

To quote Dr. Parkes :—" It has been proved, over and over

EFFECT OF SANITARY WORKS ON THE GENERAL ANNUAL DEATH-RATE AND ON THE MORTALITY FROM TYPHOID FEVER AND PHTHISIS.*

	DEATH-RATE PER 1,000 OF POPULATION.		Degree of change in Typhoid Death-rate.	Degree of change in Phthisis Death-rate.	Influence of Sewage Works on Subsoil.
	Before construction of works.	After construction of works.			
	1	2	3	4	5
Alnwick, . .	26·2	24·7	−36 p.c.	+20 p.c.	No drying.
Ashby, . . .	21·6	20·2	−56 ,,	+19 ,,	Some drying.
Banbury, . .	23·4	20·5	−48 ,,	−41 ,,	Much drying.
Bristol, . . .	24·5	24·2	−33 ,,	−22 ,,	Some drying.
Brynmawr, . .	27·3	23·2	−56 ,,	+ 6 ,,	No notable change.
Cardiff, . . .	33·2	22·6	−40 ,,	−17 ,	Much drying.
Carlisle, . . .	28·4	26·1	− 2 ,,	+10 ,,	Drying with local effects.
Chelmsford, . .	19·6	21·5	+ 5 ,,	+ 0 ,,	Slight drying.
Cheltenham, .	19·4	18·5	−37 ,,	−26 ,,	Some drying.
Croydon, . .	23·7	19·0	−63 ,,	−17 ,,	Much drying.
Dover, . . .	22·5	20·9	−36 ,,	−20 ,,	Local drying.
Ely, ...	23·9	20·5	−56 ,,	−47 ,,	Much drying.
Leicester, . .	26·4	25·2	−48 ,,	−32 ,,	Drying.
Macclesfield, .	29·8	23·7	−48 ,,	−31 ,,	Much drying.
Merthyr, . .	33·2	26·2	−60 ,,	−11 ,,	Some recent drying.
Morpeth, . .	26·2	24·7	−40 ,,	− 8 ,,	No change.
Newport (Mon.),	31·8	21·6	−36 ,,	−32 ,,	Local drying.
Penrith, . . .	25·3	25·0	−55 ,,	− 5 ,,	No change.
Penzance, . .	22·1	22·2	+ 6 ,,		
Rugby, . . .	19·1	18·6	−10 ,,	−43 ,,	Some drying.
Salisbury, . .	27·5	21·9	−75 ,,	−49 ,,	Much drying.
Stratford-on-Avon	21·7	20·2	−67 ,,	− 1 ,,	Some local drying.
Warwick, . .	22·7	21·0	−52 ,,	−19 ,,	Some drying.
Worthing, . .	15·5	15·3	+23 ,,	−36 ,,	Some drying

again, that nothing is so costly in all ways as disease, and that nothing is so remunerative as the outlay that augments health, and in doing so augments the amount and value of the work done."

* Compiled from the *Ninth Report of the Medical Officer of the Privy Council*, 1866.

Again, as Dr. Lyon Playfair wrote—"The record of deaths only registers, as it were, the wrecks which strew the shore, but it gives no account of the vessels which were tossed in the billows of sickness, stranded and maimed as they often are by the effects of recurrent storms."

At present we have no means of arriving at an accurate estimate of the amount of sickness in a community, although this information, if available, would prove of the greatest interest and value. It may be taken for granted, however, that a high death-rate means a high sickness rate, and that the one bears a fairly constant ratio to the other.

So far, we have considered the effect that improved sanitation has had on the death-rate of the community as a whole. We will now go a step farther, and consider the death-rate, and, consequently, also the health-rate, as influenced by condition and surroundings.

The first point that strikes one is the difference between the death-rate of rural as compared with urban districts. Take Staffordshire, for example, and we find that the average rural annual death-rate is 12·8 per thousand of the population, as compared with 14·7, the urban rate. It is true that the age and sex constitution, which greatly influences the death-rate, differs, as a rule, in urban and rural districts; but the advantage, so far as this is concerned, is certainly in favour of towns with their large industrial populations containing a greater proportion of young adults, among whom, other things being equal, the death-rate is low. As a matter of fact, however, the difference between urban and rural death-rates is less marked now than in former years, owing probably to relatively greater advance in town sanitation, bringing the urban populations into closer approximation with the rural as regards wholesomeness of surroundings.

Among the conditions that influence the death-rate, to occupation must be given an important place, and, without going too fully into the question, the following table shows in a striking manner how this operates, particularly in the case of two classes of disease—viz., phthisis and diseases of the respiratory organs :—

Comparative Mortality of Males, aged 25 to 65, engaged in Certain Dust-inhaling Occupations, from all Causes and from Pulmonary Diseases.

	Comparative Mortality Figure, 1900-2, that of Males, aged 25-65, being 1,000.	Phthisis.	Diseases of the Respiratory Organs.	Phthisis and Diseases of the Respiratory Organs.
Coal Miner, . . .	846	85	189	274
Carpenter, Joiner, . .	769	144	120	264
Baker, Confectioner, . .	852	156	150	306
Mason, Builder, Bricklayer,	862	188	176	364
Wool Manufacture, . .	927	157	157	314
Cotton Manufacture, .	1,037	192	207	399
Quarryman, . . .	905	186	204	390
Cutler, ...	1,460	516	296	812
File Maker, . . .	1,602	375	316	691
Earthenware Manufacture,	1,420	277	464	741
Cornish Miner, . . .	2,169	838	739	1,577
Agriculturist, . . .	559	79	82	161

We must not stop to discuss the process by which these trades exercise their baneful effects; why in a given number of coal miners only 85 deaths occur from phthisis, whereas, among a corresponding number of Cornish miners, 838 deaths occur from that disease—nearly ten times as many—the figures are given merely to show that occupation does influence the death-rate, and to a very large extent. In recent years much has been done in the case of some of these trades, as well as in others, to diminish this wholesale sacrifice of life, but much still remains to be done, as apparently our present legislators are aware. The responsibility is a serious one; for the prostration of the bread-winner of a family for years possibly, by an illness which in the end proves fatal, must involve an amount of misery, poverty, and distress beyond conception.

Certain of these trades operate injuriously upon those engaged in them by reason of their nature, but, on the other hand, there are some trades which need not cause injury, provided they are carried on under conditions less unfavourable to health than is frequently the case.

The two following tables give the mortality in Glasgow in 1885 from all causes, as well as from certain classes of disease

that are especially liable to be influenced, both as regards prevalence and fatality, by insanitary surroundings. Of course the conditions of life in other respects of the occupants of small, as compared with large houses, are not comparable, but apart from this, there can be no doubt that cleanliness of the atmosphere, as affected by density of population, is an all-important factor in the result :—

GLASGOW, 1885.

INCIDENCE OF ANNUAL DEATH-RATE PER 100,000 ON POPULATION INHABITING HOUSES OF—

	1 and 2 Rooms.	3 and 4 Rooms.	5 Rooms.
All Diseases, . . .	2,650	1,950	1,100
Zymotic Diseases, . .	478	246	114
Lung Diseases, . . .	985	689	328
Diseases of Nutrition in Children under 5 years, . .	480	231	91

GLASGOW, 1885.

OVERCROWDING AND DEATH IN A GROUP OF TEN FAMILIES OF FIFTY PERSONS IN HOUSES OF—

	1 and 2 Rooms		3 and 4 Rooms.		5 Rooms.	
	One Person dies in every					
	Yrs.	Mths.	Yrs.	Mths.	Yrs.	Mths.
All Diseases, . . .	0	9	1	0	1	10
Zymotic Diseases, . .	4	2	8	1	17	6
Lung Diseases, . . .	2	0	2	10	6	1
Diseases of Nutrition in Children under 5 years, . .	4	2	8	6	22	2

To put it shortly, nearly two and a-half times the number of people die from all causes who live in houses of one and two rooms, as compared with those who live in houses with five rooms and upwards; and in the case of zymotic diseases three times, lung diseases four times, and diseases of nutrition in children five times the number die in the small, as compared with the large houses.

In the second table, the same point is exemplified in a different manner. Both these tables deserve careful study; the figures they contain are taken from a large district, and, therefore, the operation of chance is less likely to invalidate the conclusions one may draw from them.

These observations have been continued in Glasgow, and the following table sets forth figures which were published in 1901:—

Glasgow, 1901.—Deaths and Death-rates from "All" and "Certain" Causes in Houses of Several Sizes.

	All Causes. Death-rate per 1,000.	Zymotic. Death-rate per 1,000.	Phthisis. Death-rate per 1,000.	Respiratory Diseases (including Croup). Death-rate per 1,000.
One apartment,	32·7	7·4	2·4	7·6
Two apartments,	21·3	4·5	1·8	4·6
Three apartments,	13·7	1·9	1·2	2·4
Four apartments and upwards,	11·2	1·0	0·7	2·0

As regards the significance of these figures, the same comments apply as in the case of the earlier figures.

As already pointed out, from such statistics one is not justified in attributing the excessive mortality entirely to overcrowding. The conditions of life as regards occupation, food, and general surroundings have an important bearing on the question, as well as the fact that the population living in houses of five rooms and upwards includes domestic servants, a class in which by reason of sex and age, the mortality is low.

The following table, A, although compiled on different lines, illustrates the same point, and is not open to the same objection. In this case, owing to the character of the localities selected, the inhabitants of each may fairly be compared with each other as regards condition and surroundings, so that, apart from the fact that no correction has been made for age and sex constitution, any difference in the rate of mortality may be attributed to the one circumstance in which the localities differ—viz., the proportion in each of back-to-back houses—and as this feature in its result (by reason of less possibility of free ventilation) corresponds to overcrowding, to that cause must the difference in the mortality be attributed.

A.—Death-rate and Back-to-back Houses* (Salford).

		Population.	Annual Death-Rate per 1,000 Living from				
			All Causes.	Pulmonary Diseases excluding Phthisis	Phthisis.	Seven Chief Zymotic Diseases.	Diarrhœa
		1	2	3	4	5	6
Greengate Sub-District.	Group 1.—No back-to-back houses, . .	8,713	27·5	6·6	2·8	4·5	1·42
	Group 2.—Average proportion of 23 per cent. of back-to-back houses, ...	11,749	29·2	7·8	3·3	4·8	1·55
	Group 3.—Average proportion of 56 per cent. of back-to-back houses, ...	11,405	30·5	7·9	3·6	6·2	2·12
Regent Road Sub-District.	Group 1.—No back-to-back houses, . .	54,264	26·1	5·7	2·7	4·9	1·54
	Group 2.—Average proportion of 18 per cent. of back-to-back houses, ...	8,773	29·1	7·5	2·7	4·9	1·85
	Group 3.—Average proportion of 50 per cent. of back-to-back houses, ...	4,380	37·3	8·6	4·5	7·6	2·83

* Compiled from Joint Report to the Local Government Board by Dr. Barry and Mr. P. Gordon Smith on Back-to-Back Houses, February, 1888

More recent confirmatory evidence of the advantages of through ventilation will be found in a report to the Local Government Board by one of the Board's Medical Inspectors, Dr. Darra Mair, published in July, 1910. In this report every precaution has been taken to exclude error by ensuring, as far as possible, that the different groups of figures are strictly comparable. The enquiry was not confined to one town, but was extended to thirteen towns in the West Riding of Yorkshire ; the figures cover a period of ten years, and relate only to families living in houses of a good type in healthy areas. Moreover, for the first time in such enquiries, statistical error arising from differences in the age and sex constitution of the populations embraced in the enquiry was provided against.

From data supplied in this report I have compiled Table B. to allow of comparison with Table A ; and it will be seen that the general death-rate in back-to-back houses in rows exceeds that for houses having through ventilation by over 20 per cent. : the mortality from pulmonary diseases, excluding phthisis, by about 29 per cent. ; from phthisis by over 12 per cent. ; and from infectious diseases by over 18 per cent. The report also shows that the increased death-rate in back-to-back houses was specially apparent among children and old persons, attributable, in the main, to excessive mortality from lung diseases, and from diseases especially associated with defective growth and development in young children.

B.—Mean Corrected Death-rates (1898-1907) in Through Houses and in Back-to-back Houses (in Rows) in Thirteen Industrial Towns in Yorkshire, the houses being in good structural condition and situated in healthy areas.*

	Number of Houses.	Population.	Annual Death-rates per 1,000 Living, from			
			All Causes.	Pulmonary Diseases, excluding Phthisis.	Phthisis.	Infectious Diseases.
Through Houses, .	1,567	6,784	16·15	3·16	1·15	1·35
Back-to-back Houses in rows,	1,783	6,737	19·46	4·44	1·29	1·60

* Compiled from Report to Local Government Board by Dr. Darra Mair, July, 1910.

This report also contained data regarding the relative death-rates in back-to-back houses not in rows, but in blocks of four, an arrangement which allows of partial through ventilation, and, speaking generally, it may be said that the rates in such houses were midway between those in through houses and purely back-to-back houses.

In submitting this report to the Local Government Board, Dr. Newsholme, the Medical Officer of the Board, writes :—"So far as statistics, compiled with the utmost regard to accuracy and strict comparability, can settle a question of this kind, it is certain that back-to-back houses, even those of a good type in healthy surroundings, are decidedly less healthy than through houses of a similar type, and that their provision as dwellings for the working classes is undesirable. By the Housing, Town Planning, etc., Act, 1909 (section 43), the future erection of dwellings of this kind is made illegal." *

The foregoing tables of statistics have been introduced, in the first place, to show that already much good has resulted from sanitation, and, therefore, inspectors need not be discouraged if they fail to see any immediate result from their work, and, in the second place, to demonstrate that much still remains to be done. Neither need we be discouraged if from some temporary cause the satisfactory decline in the death-rate, as shown in the table on page 3, should be interrupted, as indeed might have been the case during the quinquennial period ending 1895, owing to frequently recurring serious outbreaks of influenza. To the prevalence of influenza, which, directly or indirectly, proved so fatal among all classes of the community, especially during the earlier part of that period, may fairly be attributed the relative check to the continued decline in the death-rate. It must be remembered, however, that although this affection is undoubtedly infectious, we have no reason to suppose that it is in any way associated with insanitary conditions. Nevertheless, as it belongs to the infectious class of disease, we must look upon it as being preventable ; but as the cases are frequently of so mild a nature as to escape recognition, preventive measures in the shape of

* The three following papers will be read with profit by those who are interested in the housing of the working-classes :—1. *The Vital Statistics of Peabody Buildings and other Artizans' and Labourers' Block Dwellings.* By Sir A. Newsholme, K.C.B. (read before the Royal Statistical Society, Feb. 17, 1891). 2. *Model Dwellings in London and Overcrowding on Space.* 3. *Block Dwellings for the Working Classes.* Both the latter by Louis C. Parkes, M.D. (read respectively before the Royal Sanitary Institute, Feb. 11, 1891, and the Society of Medical Officers of Health, March 14, 1913).

isolation and disinfection are hardly practicable. Fortunately past experience justifies the conclusion that when we have seen the last of the malady, it is not likely soon to reappear amongst us in epidemic form.

These, then, are some of the questions in which an intelligent Inspector must take an interest, but they are not by any means all. He must make himself familiar with the principles of Sanitation, and acquire a practical knowledge of the various dangers to health met with from day to day, in order to be in a position to protect the public from the effects of their own ignorance and carelessness, as well as from ignorance, carelessness, and fraud on the part of workmen.

In the following pages the principles that ought to guide him in the discharge of his duties will invariably precede detailed description; for it is a common experience that ignorance of the principles with which all details must comply not infrequently results in a useless expenditure of money, and brings discredit on the Sanitary Authority and their officials. It does not follow that the structural alterations called for in one case are equally necessary, or indeed suitable, in all; what may be necessary under certain circumstances, may under others be inexpedient. Again, more than one sanitary appliance may be admissible in a given case, and unless the Inspector appreciates the object that is to be attained, he may condemn a perfectly suitable appliance, simply because, in detail, it does not correspond with what he has seen used under similar circumstances before.

It will not infrequently be the duty of an Inspector to point out to the owner of a property who, it may be recently, has spent a considerable sum in sanitary (?) work, that, through faulty work, things are no better than they were before, but, in doing so, he must be perfectly confident of his ground, a confidence that can only be the outcome of a sound knowledge of the principles of Sanitation.

Inspectors may learn much by extending their field of observation to other districts than their own, when opportunity offers, and it is most desirable that they should keep their knowledge up to date by reading and attending meetings of societies for the discussion of sanitary questions among themselves. Such discussions will tend to keep alive an interest in work which is daily growing in importance, and promote that efficiency which alone will insure success.

It is important that Inspectors should take a comprehensive view of what is expected of them, and remember that they are

workers in a wide field of labour. In order that they may successfully contend against the ignorance that prevails on all sides, they themselves must possess a knowledge of the general laws in operation in Nature, with which man's action must comply if health is to be maintained. Nature is a vast laboratory in which chemical and biological changes are in perpetual operation; no new matter is formed. What exists simply assumes a variety of shapes and conditions in accordance with the circumstances under which it is placed—so growth and decay go on; what are living cells of one animal to-day form the food of other animals or plants to-morrow, or, it may be, become for a time constituents of the inorganic world, to be redissolved and again appropriated by organic matter. These changes involve death and decomposition, and, under certain circumstances, danger to neighbouring life, a danger, however, against which we often possess a remedy in Nature herself, if we study her laws and take advantage of them.

CHAPTER II.

WATER-SUPPLY, DRINKING WATER, POLLUTION OF WATER.

Water a Prime Necessity of Life.—Water is one of the prime necessities of life, and that all should be provided with a pure supply is by no means the least important of the health requirements. It is a vital element of our food, and assists in the building up of our tissues, of which it constitutes one hundred parts in each hundred and fifty; it preserves the fluidity of the blood; aids in the excretion of effete matter; and assists in maintaining our bodies at a uniform temperature under varying conditions of heat. It is also essential for drinking purposes, for cooking, and for personal and household cleanliness. By the community at large it is required for public baths, for water-closets, for flushing sewers, for the cleansing of streets, for use of animals, and for manufacturing and various other purposes. It is important, therefore, that the supply should be plentiful as well as pure.

Sources of Supply.—From whatever source our water-supply may be obtained, it is dependent for replenishment upon the rainfall. From the surface of the land, rivers, lakes, and oceans, evaporation takes place through the agency of the sun's heat, and the atmosphere has the power of retaining moisture, in the form of invisible vapour, in quantities varying with the temperature. The higher the temperature, the greater capacity the atmosphere has for retaining moisture in this invisible form. Should the temperature fall, which it may do from a variety of causes, a point is at length reached which is called **saturation point,** when the atmosphere contains as much moisture as it can possibly hold in the form of vapour; and if the temperature should be further reduced, a portion of the moisture is condensed into fine globules, and becomes visible as mist. Clouds are simply mist, and their circumscribed and apparently solid appearance is the result of their being viewed from a distance.

By the cooling of the atmosphere still farther, the globules of moisture coalesce into larger particles, until a point is reached, at which, by reason of their weight, they can no longer be

retained in suspension, and are deposited in the form of rain. If the point of saturation of the atmosphere should not be reached—that is, if condensation should not occur—until the temperature is below freezing point (32° F.), then the deposit occurs in a solid form, and falls to the ground as snow.

The average annual rainfall in Great Britain is about 30 inches, varying from 20 inches on the East Coast to as much as 70 inches, or more, on the West Coast of Scotland and Ireland. At certain localities in the English lake district 150 inches is not an unusual amount. One inch of rainfall a day, or even more, is not an infrequent occurrence in this country; in some countries there may be much more, and in these the annual fall may amount to 400 inches or more.*

After having fallen, a certain portion of the rain water is lost by evaporation, another portion runs off the surface and the remainder penetrates into the soil, the extent to which each takes place being regulated by a variety of circumstances, such as the amount of the rainfall, the temperature, the slope of the surface, and the porosity—that is, the openness of the soil. In winter a larger quantity penetrates or runs off the surface in the direction of the natural drainage than in summer, when, by reason of the increased temperature, evaporation is very rapid, and when it requires a heavy shower of rain to overcome the absorbent properties of the warm dry surface, so as to enable any portion to reach the water-courses, especially in flat districts.

Subsoil Water.—That portion of the rainfall which penetrates the surface continues to descend until, sooner or later, it meets with an impervious stratum, where its downward course is diverted in one direction or another, in accordance with the natural fall of the stratum in question. This fall is usually in the direction of the general surface fall—that is, towards the natural water outlet of the area. It must be remembered that the pace at which this subsoil water travels is very slow indeed, by reason of the obstruction offered to its progress by the soil through which it has to travel, and, for this reason, it varies with the density or looseness of the soil in question. Now it is this subsoil water which we tap in sinking what we call our **surface wells**; it, therefore, contributes largely to our domestic water-supply. As regards its qualities for this purpose, more will be said presently.

It will be understood from the above description that the

* For a fuller account of the causes of the rainfall, etc., see *Elementary Meteorology*, by R. H. Scott (International Scientific Series).

depth of a surface well will vary according to the distance from the surface of the impervious stratum upon which the subsoil water rests.

It may here be stated that this has an important bearing upon the dampness of a locality, and for this reason it is of the utmost importance, especially in the case of low-lying districts, that no obstacle should be offered to the natural flow of the stream or water-course, which is the ultimate outlet of the water in question. The placing of weirs along the course of rivers, for the purpose of back-pounding the water, in order that it may be used as a motive power for mills, is a custom which, unfortunately, still prevails throughout the country.

Deep Water.—Beneath the impervious stratum just mentioned, we come upon other porous strata, and in them supplies of water which have percolated downwards from distant points where these strata reach the surface (Fig. 1). By sinking deep

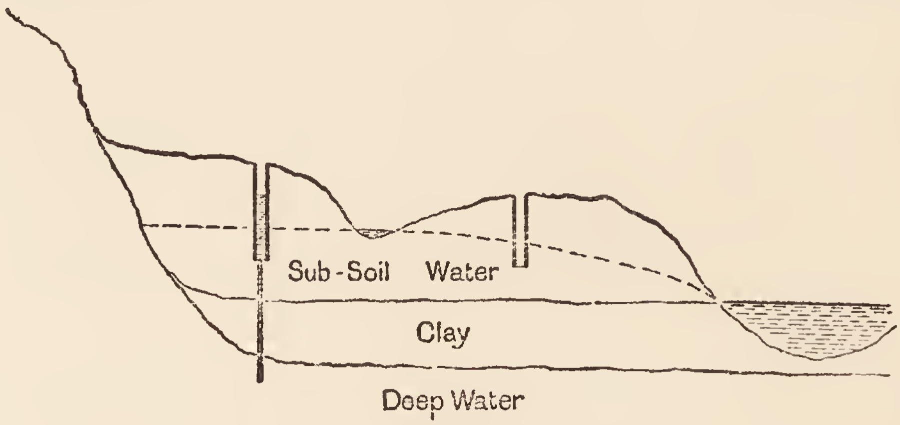


Fig. 1.

wells into such a stratum at its lower part we tap this supply, and, if the surrounding country should be much higher than the spot selected for the well, the pressure may be so great as to raise the water to the surface at the site of the well or even above it. Hundreds of feet may have to be pierced to reach this source of supply, and this plan is adopted by many large towns.

Springs.—These, which are outflows of water from the earth, are divided into two classes, **surface springs** and **deep springs**—the former are found mostly on the face of slopes, and their presence is dependent upon the fact, that at this point the impervious stratum, say of clay, which supports the subsoil water, rises to the surface and thus opposes a barrier to its onward progress. Deep springs, on the other hand, are due to the presence of a fissure in the impervious stratum, which enables the water below it to rise to the surface. The fact that surface springs

are liable to become dry after a long interval without rain, while deep springs are nearly always permanent, will, therefore, be easily understood. The sketch (Fig. 1) will assist the reader in understanding the above somewhat curtailed description.

Character of Different Waters.—The sources of our water supply then may be from the rainfall, rivers, lakes, springs, and wells (superficial and deep). It does not come within the province of an inspector to say which of these yields water best suited for domestic purposes; his attention ought more especially to be directed to the risks of contamination to which water may be exposed during storage and distribution. The natural characteristics of the water from each of these sources may be shortly summarised as follows:—

Rain water, although well aërated, is flat and insipid, owing to absence of mineral matters, and in towns it takes up so much impurity from the air during its transit, and from the various collecting areas, that it can hardly be looked upon as a satisfactory supply. In some districts in the country, where well supplies cannot be obtained, rain water, with proper storage and filtration, may be used for drinking purposes, but, as all soft waters possess considerable solvent powers, and as, owing to the intermittent character of the water supply, it is necessary to provide considerable storage room, great attention must be paid to the precautions to be observed in the construction of tanks (see p. 24).

Hard and Soft Water.—Rain water is excellent for washing purposes, as, being soft, less soap is required than in the case of hard waters. By a "hard" water is meant a water which contains a large quantity of saline constituents, of such a kind as to interfere with the formation of a lather with soap (usually carbonates and sulphates of calcium and magnesium). Before a lather can be formed, in the case of such a water, the saline ingredients must form with the soap a curdy material, so that a quantity of soap, varying in amount with the hardness of the water, is thus wasted. There are two kinds of hardness, temporary and permanent. The former is owing to the presence of certain salts (carbonates) that are deposited on boiling, and not redissolved, and the latter to others (sulphates) that are not so deposited. The effect of boiling is to liberate carbonic acid and so reduce the soluble bicarbonates to insoluble carbonates, thus getting rid of the so-called temporary hardness, whereas, as regards the sulphates, boiling does not effect any change, therefore the hardness due to such salts is said to be permanent.

In some cases the only available water supply is so hard as to necessitate special treatment to reduce its hardness before distribution. This is effected by the addition of lime water, which deprives the water of its temporary hardness. The lime combines with the carbonic acid in the water forming an insoluble carbonate, which, together with the soluble carbonates already present in the water, and which have been rendered insoluble by the removal of the free carbonic acid, is deposited on standing for a time in tanks.

Water-supply of Towns.—Some large towns are provided with excellent water from lakes, which are simply large natural reservoirs, supplied by mountain-streams. Other towns construct reservoirs by damming up mountain-streams in their passage along valleys, and thus obtain good and plentiful supplies of water. Rivers and streams, on the other hand, which pass through cultivated land and populous districts, are unsafe, partly because of the manure which is applied to the land, and, in too many instances, because of sewage pollution. *Water from surface wells must always be viewed with suspicion by reason of the danger of pollution from similar sources.* Deep wells, on the other hand, as a rule yield excellent waters, although, in some instances, the various salts they contain in solution are present in such quantity as to be objectionable by causing deposits in boilers. By reason of their hardness, also, such waters are often not very suitable for washing purposes, and in some instances, from the same cause, they may be injurious to health; the latter consideration, however, is purely a medical one.

The following condensed summary of the broad characteristics of waters from different sources is given by the earlier Rivers' Pollution Commissioners:—

Wholesome	1. Spring water.	Very palatable.
	2. Deep-well water.	
	3. Upland surface water.	Moderately palatable.
Suspicious	4. Stored rain water.	
	5. Surface water from cultivated land.	Palatable.
Dangerous	6. River water to which sewage gains access.	
	7. Shallow well water.	

Quantity of Water Required.—The quantity of water required by towns for all purposes varies with circumstances, such as the general presence or absence of water-closets, manufacturing

processes, etc. The average supply per head for the London districts is 35 gallons in the twenty-four hours, varying from 25 to 37 gallons. Some towns exceed this amount, while others do not reach it; in Glasgow, for example, the daily supply is 58 gallons, while in Sheffield it is only 25. Dr. Parkes has calculated the amount used per head in a household of fairly cleanly people at 12 gallons; in this calculation, 2½ to 3 gallons are allowed for a daily sponge bath, and it includes clothes-, utensil-, and house-washing, but not a water-closet supply.

	Gallons daily for each person.
Cooking,	·75
Fluids, as drink (water, tea, coffee),	·33
Ablution, including a daily sponge-bath, which took 2½ to 3 gals.,	5
Share of utensil- and house-washing,	3
Share of clothes (laundry) washing, estimated,	3
	12

The same writer states that if from scarcity of supply the amount must be limited, 4 gallons is the least that ought to be allowed, and that with this amount there cannot be daily washing of the whole body, and there must be insufficient change of underclothing. This question is of importance to Sanitary Authorities of rural districts in determining, for example, whether the yield of certain wells is sufficient.

A double system of water-supply has been suggested; pure for drinking and less pure for washing purposes in cases in which difficulty has been experienced in obtaining a sufficient supply of pure water for all purposes; but there are two objections to this plan—first, the cost in providing duplicate pipes, and second, the danger that, through carelessness, the one supply might be substituted for the other.

Collection and Storage.—Allusion has already been made to the plan adopted for the collection of water on a large scale by taking advantage of Nature's reservoirs in the shape of large lakes, or by constructing an artificial lake by damming up a stream in a valley. Under such circumstances the amount of storage necessary is dependent upon the rainfall of the district and the extent of the collecting area.* In the case of deep-well supplies the water is pumped into service reservoirs large enough to contain several days' supply, but the collection and storage of water on a large scale is an engineering question outside the

* See p. 30 as to purifying effect of storage.

province of a sanitary inspector. On the other hand, the construction of wells for local supplies (which are simply small reservoirs), and cisterns, is of vital importance, and the details ought to be familiar to all inspectors.

Wells are of two descriptions—surface and deep. The former, as already mentioned, tap the subsoil water, while the latter pierce the impervious stratum upon which this water rests, and tap the water-bearing stratum below. The distinction between the one and the other is not, strictly speaking, a matter of depth, for what is known as a "surface" or shallow well in one district may be deeper than a deep well in another, from the fact that, in the latter case, the impervious stratum may be shallow and near the surface. Also, what is, strictly speaking, a deep well may be very shallow, provided it is sunk at a spot where the stratum which yields the deep water crops up close to the surface. The ordinary surface well which one meets with throughout rural and small urban districts is constantly liable to pollution from various sources, unless certain precautions are observed as regards its position and construction. Filth from a leaking cesspool, privy-midden, manure heap, or faulty drain, will find its way into such a well from a considerable distance off. Such percolation is sometimes demonstrated by the fact that well water may smell of disinfectants that have been thrown down the drains.

A surface well drains an area which varies in accordance with the depth to which the water in the well is lowered by pumping and the nature of the ground in which it is sunk. The more porous the ground, the greater is the distance from which the water travels towards the well, and, from experiment, this distance has been stated to vary from 15 to 160 times the depression which results from pumping.

Whether these figures be accurate or not, there is no question that surface pollution does find its way into wells, from points that one might consider a safe distance off; it is, therefore, of vital importance to observe every precaution in their construction.

Well Making.—The precautions to be observed in making a well are as follows:—In the first place, the spot selected for a surface well ought to be as far removed from all sources of pollution as possible, and in the opposite direction to the natural fall, so as to tap the water previous to its reaching the polluting source, and not after it has travelled past it. The importance of this will be understood from the description already given

of the course that the subsoil water takes (see p. 15). In addition to this, the lining of the well must be so constructed as to be quite impervious to soakage from the surface immediately surrounding it. In place of the brickwork being loosely laid around it, which is a common practice, it ought to be set in cement down to the water level, and, as an additional precaution, it is well to interpose a layer of puddled clay all round, between the brickwork and the adjoining soil. Every well ought to be provided with a pump, the brickwork being carried above the surface and covered by means of stone slabs, carefully adjusted and sealed with cement. By reason of such precautions, in place of entering the well direct, all surface water must percolate through the intervening stratum, and, in doing so, become more or less purified.

In the earlier "Rivers' Pollution Commissioners' Sixth Report" the following remarks appear, which are given here because they express very forcibly what one often finds to be the case :—

"Twelve millions of country population derive their water almost exclusively from shallow wells, and these are, so far as our experience extends, almost always horribly polluted by sewage and by animal matters of the most disgusting origin. The common practice in villages, and even in many small towns, is to dispose of the sewage and provide for the water supply of each cottage, or pair of cottages, upon the same premises. In the little yard or garden attached to each tenement, or pair of tenements, two holes are dug in the porous soil; into one of these, usually the shallower of the two, all the filthy liquids of the house are discharged; from the other, which is sunk below the water line of the porous stratum, the water for drinking and other domestic purposes is pumped. These two holes are not infrequently within 12 feet of each other, and sometimes even closer. The contents of the *filth-hole*, or cesspool, gradually soak away through the surrounding soil, and mingle with the water below. As the contents of the *water hole*, or well, are pumped out, they are immediately replenished from the surrounding disgusting mixture, and it is not, therefore, very surprising to be assured that such a well does not become dry even in summer. Unfortunately excrementitious liquids, especially after they have soaked through a few feet of porous soil, do not impair the palatability of the water; and this polluted liquid is consumed from year to year without a suspicion of its character, until the cesspool and well receive infected sewage, and then an outbreak of epidemic disease compels attention to the polluted water. Indeed, our acquaintance with a very large proportion

of this class of potable waters has been made in consequence of the occurrence of severe outbreaks of typhoid fever amongst the persons using them."

To some extent these remarks apply to-day more especially in rural districts, although, undoubtedly, for a good many years past, the abolition of surface well supplies in populous areas, both urban and rural, has been more generally enforced. In certain rural areas, however, where the houses are widely scattered and there are no public supplies conveniently available, the surface well will have to be maintained, and it is the duty of health authorities to see that such wells are so constructed and situated as to minimise the risks to health from possible contamination. At the same time, it must be remembered that, while a public supply may not be available, it is frequently possible to provide even small groups of houses in rural districts with pure water from a common source by means of small local schemes, and the possibility of this must always be considered before an authority comes to the conclusion that there is no alternative to the continuance of private well supplies.

Norton's Abyssinian tube well is constructed by driving tubes into the soil, one length being screwed on to another, and the lowest segment having a series of perforations at the free end. When the subsoil water is reached, a pump is attached to the tube, and after pumping for some time, the water, which at first is dirty, becomes clear and remains so, as a cavity which corresponds to the ordinary well is formed at the end of the pipe owing to the gradual removal of the soil by pumping.

This is an excellent plan of obtaining a water-supply for villages situated on gravel, provided the water is not very far from the surface.

For precisely the same reasons as are stated above, it is equally necessary, in the case of deep wells, to protect the surface by carrying the impervious brickwork down as far as the impervious stratum. A very striking example of the effect of not doing so was met with some years ago in the Stafford Rural District in the case of a deep well belonging to a school. The water in this case was highly polluted, so much so that it had a most offensive odour, and in the absence of any local insanitary surroundings, it was at first difficult to account for it; on opening the well, however, and introducing a light, the cause was at once apparent. Down to a distance of 12 feet from the surface, the brickwork was perfectly clean, but at this point a well-defined line was formed by the entrance of a filthy, slimy-looking fluid,

which stained the bricks down to the water-level 50 or 60 feet below. In this case, the only source of pollution was from a manure heap in a farm yard 70 or 80 yards away, from which, no doubt, percolation had occurred through the surface gravel, along an impervious bed of clay. Had the brickwork of the well in question been built in an impervious manner down to this clay, no such pollution could have occurred.

The quality of cement used is very important, the **best Portland cement** being alone admissible for this, as for all sanitary work. The proportion of added sand ought, for this particular purpose, to be two of sand to one of cement, and the two ought to be thoroughly well mixed before the water is added. The sand selected must be clean and fine, and quite free from any dirt or clay, otherwise the cement will not set. Builders and workmen require careful watching as regards these points.

In all cases in which well-pollution is suspected, it is advisable to open the well in order to ascertain whether there is any evidence of the penetration of sewage matter above the water level. If such be the case, at one point or another, the brickwork, in place of presenting a clean, red surface, will be discoloured in a manner which, when once seen, will never be mistaken. Apart from this, it is highly desirable that wells should be **opened periodically** for the purpose of being cleansed, as, however well constructed they may be, with time impurity may arise.

Pumps.—There are two kinds of pumps, the ordinary **suction pump** and the **forcing pump.** The former will answer the purpose so long as the distance the water has to be raised does not exceed from 30 to 33 feet; in fact, as a rule, taking imperfections of mechanism into account, 25 feet may be looked upon as the limit. In the case of deeper wells, it is necessary to fix the more elaborate and expensive forcing pumps; hence it is that in practice one so often finds open wells with a bucket and windlass for raising water. In such cases, the danger of surface pollution is increased, and if the arrangement be allowed to continue, as in the case of small cottages probably it will, the greatest care must be taken to see that the top of the well is so situated with regard to the surface as not to permit of drainage into it. A good fitting cover ought to be insisted upon, otherwise dead leaves and other decaying matter will find their way into the well.*

Cisterns.—In cases where cisterns are necessary certain precautions must be attended to in their construction.

* For a full and simple description of the construction of pumps, see *Well Sinking*, Weale's Rudimentary Series

(1) *They should be constructed of a material that will not impart any injurious quality to the water.* Galvanised iron and slate both answer the purpose well; the latter, however, although the best in other respects, is heavy, and it is difficult to avoid leakage through the joints; these should be carefully made with cement. Lead and wood are bad materials for use in the construction of cisterns. The risk of metallic contamination in the case of the former has often been demonstrated, and, as regards the latter, sooner or later decay takes place and organic contamination results.

(2) They should be easily accessible, and, while the sun's rays ought to be excluded, the place where they are fixed must not be dark. These requirements are essential, so as to afford every facility for inspection and cleansing. It is not unusual to find cisterns placed under floors, in situations quite unknown to the occupants of the house, until, by reason of the foul condition of the water, a search is made, and the cause, in the shape of dead and decomposing rats, is discovered.

(3) They ought to be covered in and ventilated, otherwise dirt of all descriptions will enter.

(4) The overflow pipe ought to be carried to the outside where it should either be cut short or discharge on to an open gully. It used to be a common practice to connect it direct with the soil pipe or drain, in which case it simply acts as a ventilator, and foul gases are conducted direct to the drinking water. In some instances in which this is done a syphon trap is introduced, but as the overflow pipe is only in use when the ball-tap which regulates the supply of water is out of order, this trap owing to evaporation must stand empty, and, therefore, be absolutely useless. Some years ago the author found an illustration of this fault in the case of an hospital, where, to make matters still worse, the cistern overflow pipe was connected direct with the drain from the fever wards.

(5) The supply pipe for the water-closet *must not pass direct from the cistern,* but a smaller cistern (water waste-preventer) ought to be interposed (see p. 111).

Distribution.—In public water-supplies there are two systems of distribution—the **constant** and the **intermittent.** The former is very much the better, for a variety of reasons, although the latter is the system in operation in some towns.

Constant and Intermittent Systems.—In the case of the constant system, the taps of the houses deliver water direct from the service pipes, without the intervention of a cistern, except in

the case of water-closets, which have what are termed "water waste-preventers"—small cisterns that deliver, at one time, only the requisite quantity of water for flushing purposes—and kitchen boilers, which cannot be supplied direct, but must be provided with small supply cisterns. The necessity for having large cisterns for storing water on the premises is thus avoided, while, with an intermittent supply, these are essential, otherwise, from time to time, houses would be entirely without any water. The chief objection to the storage of water in houses is the danger of pollution, which may occur from various causes already noticed. Another objection to the intermittent system is that, by periodically shutting off the water from the mains, a vacuum is liable to be created in the pipes, from gradual leakage at faulty joints, and this vacuum is replaced by foul air, or even sewage, from leaking drains, an occurrence which in more than one instance has led to an outbreak of typhoid fever. The mains, in the case of a constant supply, are always full, therefore this risk is to a large extent avoided. In addition to this, pipes running full are less liable to rust than those that are occasionally empty, as air in the presence of moisture has considerable corroding power.

Besides these advantages, in the constant system there is always an abundant supply of water in the case of fire. The disadvantage of a constant supply is that the waste from leaking pipes is greater, as the water is always at pressure in the mains; also, by reason of the great pressure in the service pipes, the various fittings must be of more perfect make, and therefore more costly. For this reason, much waste of water has resulted in cases in which a constant has been substituted for an intermittent supply without replacing the old fittings. On the other hand, in some cases where the change has been made, and the necessary fittings substituted, a diminution in waste has resulted.

Charges.—The system of charges for water may be by rate or by meter. The former is much the better for domestic supplies, as, by making a charge in accordance with the quantity consumed, an inducement is offered to economise, and economy in the legitimate use of water is certainly not what one would wish to see.

Indirectly, there is another important reason for placing no obstacle in the way of a generous use of water, and that is the cleansing effect that it has on the drains and sewers. By limiting the supply, we diminish the flushing power, and thus add to the risk of deposit, which is so highly objectionable as will be

explained in a later Chapter. Of course, in special cases, such as manufactories, it may be necessary to charge by meter.

Pipes.—Iron, with a coating of some protective material, such as Angus Smith's varnish, is what is used for mains. Lead is most generally used for house pipes, but in the case of certain waters its use is dangerous, for reasons already stated. Galvanised iron pipes are now often used, as they are not so liable to rust as plain iron pipes. The temptation to use lead pipes is very great, as they can be carried anywhere round corners by simply bending them; whereas in the case of iron pipes, joints have to be inserted at frequent intervals, not only where angles have to be passed, but also where one length has to be joined on to another.

Many materials have been suggested as a protective coating for both lead and iron pipes, but most are either unsatisfactory or too expensive for general use.

Glass-lined iron pipes are manufactured, and answer the purpose well.

Tin is used as a protective coating for both iron and lead pipes, but in this form it is hardly satisfactory.

Composite pipes, consisting of a block tin pipe enclosed in a lead pipe and solidly united together, are not so liable to be acted upon by water, and they may be bent in any direction like an ordinary lead pipe; these answer excellently.

Iron pipes treated by the Barff process are recommended by some. The process consists in raising the temperature of the pipes to a white heat (about 1,200° F.) in a chamber into which superheated steam is passed. After being exposed to the action of the steam for several hours the metal becomes coated with a protective oxide.

Impurities.—The chief impurity, indeed almost the only one that need be considered from an inspector's point of view, is that which comes from an organic source, either vegetable or animal, the latter being much the more objectionable of the two.

Both may be present in a solid form or in solution, in the former case, the water is distinctly discoloured, the colour varying in depth in accordance with the amount or nature of the contaminating material; while in the latter, notwithstanding the presence of considerable impurity, the water may be perfectly clear and wholesome looking. The absence of colour, therefore, is no sign that the water is pure; but neither is its presence a sign of dangerous pollution, for peat imparts a considerable colour to water which need not be injurious. The important

point to remember is, that a clear water need not mean a pure water, but that danger may exist even though it is beautifully sparkling and perfectly clear. Here, then, we are brought face to face with a problem which can only be solved by the chemist and bacteriologist, but as the inspector ought to appreciate the significance of the question, we must go a step farther, and explain shortly the reason why water which contains organic matter is dangerous from a health point of view.

Presence of Organic Matter—What it means.—In the first place, then, even from an ordinary point of view, it is, to say the least of it, objectionable, to drink water which contains matter in a putrefying state; but, in addition to this, evidence exists which points to the conclusion that it is directly injurious to health to do so. The real danger, however, lies in the fact that any contaminating source—for example, human excreta and refuse—may contain the poison of a disease which may be communicated through the medium in question. We know a great deal more now than we did a comparatively short time ago of the nature of the poisons which cause diseases of the infectious class, and the belief that all such diseases are associated with minute living germs is universally accepted. Many circumstances which formerly we did not understand are now explained; it is no longer difficult to realise that a water, known to be bad, may be consumed for a long period with apparent impunity, and then, suddenly, typhoid fever may attack several of the consumers. We know now that the poison reaches the well by the same channel which all along has conveyed the polluting matter.

It is obvious from what has been said that a standard of purity cannot be arrived at simply by fixing a chemical limit of admissible impurity, because, beyond stating that a certain amount of organic contamination is present, chemistry cannot go—its exact nature cannot thus be indicated. Were a standard to be fixed on such evidence as this, it would amount, in some cases, to saying that a limited number of typhoid fever germs may be admitted with impunity, which, of course, is absurd.

How to Estimate Purity of Water.—The only safe way of arriving at a conclusion with regard to the quality of a water from a chemical point of view, is to consider the analyst's report *together with the possible sources of pollution*, and, for this reason, it is most desirable to send a full account of the surrounding conditions with the sample.

The following history of an outbreak of typhoid fever, which

the author investigated several years ago, illustrates very forcibly what has just been stated. The cases were directly connected with a farm-house in which a person had died from the disease twelve months previously. Immediately on the occurrence of the cases in question, a sample of water from the well belonging to the house was sent to a chemist for analysis, with the result that it was pronounced to be perfectly wholesome. The fever attacked three occupants of the house, and three people living in different parts of the scattered district (two of whom lived over a mile away), but all of those patients worked at the farm in question, and drank the water from the said well; in fact, after an exhaustive enquiry, the details of which need not be given here, the *contagion was unmistakably traced to the farm-house well.* In the course of this enquiry, a second analysis of the water was made, and by way of comparison the water from two other wells in the immediate neighbourhood was also analysed, with the result that, although the amount of organic matter present in the case of the farm-house well came within the ordinary chemical limit of purity, it exceeded by nearly four times the quantity present in the two wells that were selected for comparison. Where, then, did this increase of organic impurity come from? There need be no difficulty in answering this question, for within four yards of the well was situated a large foul privy cesspit.*

To base one's opinion, however, regarding the quality of drinking water on chemical analysis only is by no means wise. No doubt, given a high standard of chemical purity and the absence of any likely source of contamination, one may, as a rule, come to the conclusion that the supply is a safe one, but it must be remembered that a minute amount of fæces from a typhoid case, although insufficient to materially affect the chemical results, may render the water highly dangerous. The only safe proceeding, in cases in which there is reasonable ground for suspicion, is to obtain a bacteriological as well as a chemical analysis.

Purification of Water.—In the case of a public supply direct from a deep well, the water may be pumped direct into the reservoir, but when the source is a river or mountain stream, it is usually found necessary to pass the water through a filter-bed after it has been received into reservoirs and subsidence of a great portion of the suspended impurities has taken place.†

* See *British Medical Journal,* April 2nd, 1892.

† See p. 30 as to the effect of storage in purifying water.

The Filter-Bed.—Such a filter is constructed of sand, which ought to be sharp and angular (not too fine), and gravel of various degrees of coarseness. The sand is placed on the top, and under it is the gravel which increases in coarseness, until, at the bottom, where the outlet pipes are situated, it consists of small stones. The efficiency of the filter is dependent upon the time which the water takes to percolate through, and this is regulated by the depth of the sand, which ought to be from 1½ to 2 feet, the gravel being 3 feet. Each square foot of such a filter will allow 70 to 75 gallons to pass in the 24 hours. Such filtration is chiefly mechanical owing to the straining effect of the fine mineral and organic deposit formed on the surface, which, on account of clogging, has to be periodically removed. This filter also removes dissolved organic matter to some extent by bacterial action in the presence of air in its interstices. For this reason, it is important that the process should be conducted slowly and intermittently to allow of aëration; it must be remembered, however, that the important effect is a mechanical one. It is this property of air which also mainly accounts for the increasing purity of a water, so far as dissolved organic matter is concerned, as it passes onward in rivers.

Rain-Water Filter.—For the filtration of rain water it is a common practice to construct a filter underground, in which case certain precautions are necessary. The arrangement ought to be similar, on a small scale, to that just described, but as, in this case, the filter is sunk in the ground, it is essential that the brickwork which contains the sand and gravel should be built in cement, so as to render it impervious to soakage from the surrounding soil. Sometimes, in addition to sand and gravel, charcoal is introduced, but this is objectionable, because the water has afterwards to be stored, and charcoal imparts to water a material which favours the growth of organisms. Such filters as these are apt to be neglected, on account of their inaccessibility, so, in order to facilitate regular cleansing, a convenient means of gaining access to them ought to be provided. This rule is applicable to all sanitary appliances. It is not easy, even if every facility is offered, to induce the public to systematically cleanse and inspect them, but if any difficulty stands in the way of doing so, it is hopeless.

It would appear that filtration on a large scale affords protection against water-borne diseases such as enteric fever and cholera, but only after some amount of deposit has taken place on the surface of the filter which causes it to act as a strainer

against the passage of bacteria. For this reason, it is wise to reject the first water which passes through such filters after the process of surface cleaning, to allow of the re-formation of the deposit which has been disturbed by that operation.

Fortunately for the safety of the public, the organisms responsible for water-borne disease are not very tenacious of life in that medium, a circumstance which, in all probability, not infrequently accounts for the fact that waters derived from dangerous sources are for long periods used for domestic purposes with impunity. Much light has been thrown upon this question lately by the research work of Sir A. C. Houston, Director of Water Examinations, Metropolitan Water Board. He has shown that cultivated organisms of typhoid and cholera are more tenacious of life than the uncultivated germs, and that the latter, when present in water, are destroyed by storage and exposure to light even for a short period. While agreeing that filtration is a valuable safeguard in the case of public supplies, he states that it is not always reliable, while, on the other hand, he has the greatest confidence in storage alone, even for one week, as a means of purification, and is of opinion that storage followed by filtration practically affords complete protection.

Domestic Filters.—Great ignorance prevails regarding the efficacy of domestic filters. The general opinion is that, however foul the water may be to start with, all deleterious matter is removed by their use. One is constantly told that "the water must be all right, because every drop that is used is filtered," but, as a matter of fact, all ordinary filters are of very doubtful value, for, though most of them have the power of removing turbidity from water, they are useless as preventives of water-borne diseases, and after they have been in use for some time they simply act as culture beds for micro-organisms, and so contaminate the water that passes through them instead of purifying it.

The material most frequently used as a filtering medium in domestic filters is **charcoal,** or a combination of charcoal with silica (silicated carbon filters).

In the "**Filtre Rapide**" **of Maignen,** formerly largely used in the army, the filtering medium is charcoal in the form of granules, with asbestos cloth as a straining material. Among other articles which are used as filtering media may be mentioned *spongy iron, magnetic carbide of iron*, etc.

Besides acting as strainers in removing the larger suspended particles, most domestic filters act chemically upon decomposing

organic matter in solution, as well as upon certain inorganic constituents, but their effect upon fresh organic matter would appear to be *nil*.

In this country two valuable sets of experiments with domestic filters have been conducted, the one by Col. H. H. Johnston, C.B., R.A.M.C., at the Public Health Laboratory of the University of Edinburgh,* and the other by Sir German Woodhead and Dr. Wood for the *British Medical Journal*.†

Col. Johnston's investigations were confined to four filters—namely, the Atkins, Maignen, Nordtmeyer-Berkefeld, and Pasteur-Chamberland—and the investigations of Sir German Woodhead and Dr. Wood included experiments with these filters and nineteen other well-known varieties.

As the question is one of extreme importance from a health point of view, the published accounts of both sets of investigations should be carefully studied. The following summary is given for the benefit of those who may not have an opportunity of seeing the original papers :—

Col. Johnston's experiments were conducted with Edinburgh main water, and the object he had in view was to test the power of the filters in removing the micro-organisms already present in the water, and other bacteria which were purposely added to it Having ascertained, by cultivation experiments, the number of bacteria present in the water, the filters were kept at work continuously, the filtrate being collected periodically for similar bacteriological tests.

As regards both Atkins' and Maignen's filters, the first series of experiments were made with the Edinburgh water-supply, and after one day's working, samples were collected, which, on examination, were found to contain so many organisms as to be uncountable. At the end of eight days' working the filters were again tested with a similar result. In these experiments the granular carbo-calcis was not sterilised before being used, but was thoroughly washed with distilled water ; the other parts of the filters, however, had been sterilised. Col. Johnston writes regarding this series of experiments :—" As the Edinburgh main water placed in the filters only contained 160 micro-organisms in each cubic centimetre, it is probable that the large numbers of micro-organisms found in the filtered water were derived from

* Thesis for the degree of Doctor of Science of Edinburgh University.

† An inquiry into the Relative Efficiency of Water Filters in the Prevention of Infectious Disease—*British Medical Journal*, Nov. 10, 17, and 24, and Dec. 15 and 29, 1894.

the multiplication of the micro-organisms in the pores of the unsterilised granulated animal charcoal, as well as from the micro-organisms present in the Edinburgh main water."

A second series of experiments were conducted with the same two filters after all parts of them had, it was thought, been sterilised, although, in the case of the Atkins filter, the results indicated that this was not the case. In this series distilled water containing 12 *Bacilli violacei* and 33 other micro-organisms was used, and the following are the conclusions arrived at after a series of tests made during six days' working :— "Although the Atkins filter was not sterilised by boiling for one hour at 120° C., still the enormous number of *Bacilli violacei* and other micro-organisms found in the filtered water, after one day's filtration, conclusively prove that this filter not only allows micro-organisms to pass through its pores, but the charcoal forms a suitable nidus for the growth and multiplication of micro-organisms, which are found in much greater numbers in the filtered water than in the unfiltered. Maignen's filter is of some service in removing micro-organisms from water on the first and second days of filtration, but after that it forms a suitable nidus for the growth and multiplication of micro-organisms, which are found in much greater numbers in the filtered water than in the unfiltered. These filters are, therefore, useless for sterilising water, and no reliance can be placed on them for removing pathogenic micro-organisms from drinking water."

Before considering Col. Johnston's experiments with the other two filters—the Nordtmeyer-Berkefeld and the Pasteur-Chamberland—as they are not so well known as the commoner forms of domestic filters it may be well to give a short description of each.

In general appearance, these filters (Figs. 2 and 3) resemble each other very closely, and the action of both is purely mechanical.

M. Pasteur first designed his filter (Fig. 2) for the purpose of sterilising fluids in his laboratory work, and it afterwards occurred to M. Chamberland, his principal assistant, to apply the material used in the filter for the filtration of drinking water, hence the name given to the filter. The filtering medium is a specially-prepared fine-grained unglazed porcelain in the form of a cylinder, which is open at the lower end only, where it is provided with a glazed porcelain nozzle. The cylinder is enclosed in a case through the bottom end of which the nozzle

passes, and communicating with the top end there is a pipe with a screw socket for fastening the filter on to a water tap. The water enters the outer case, filters through the cylinder into its internal cavity, and escapes through the nozzle at the lower end. Besides this form of tap filter, which works under pressure, there are other forms, one of which is shown in the drawing (Fig. 4), which act without any pressure beyond that imparted by the head of water in the top chamber, and to increase the rate of delivery, which, of course, is very much lessened by the absence of pressure, a series of filter tubes are

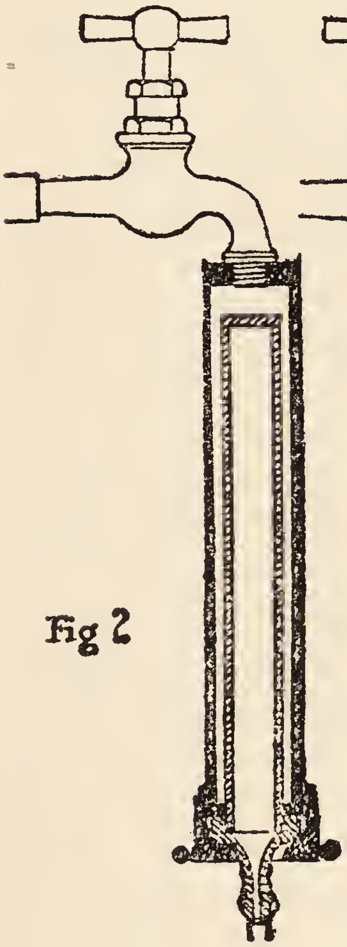


Fig 2


Fig 3

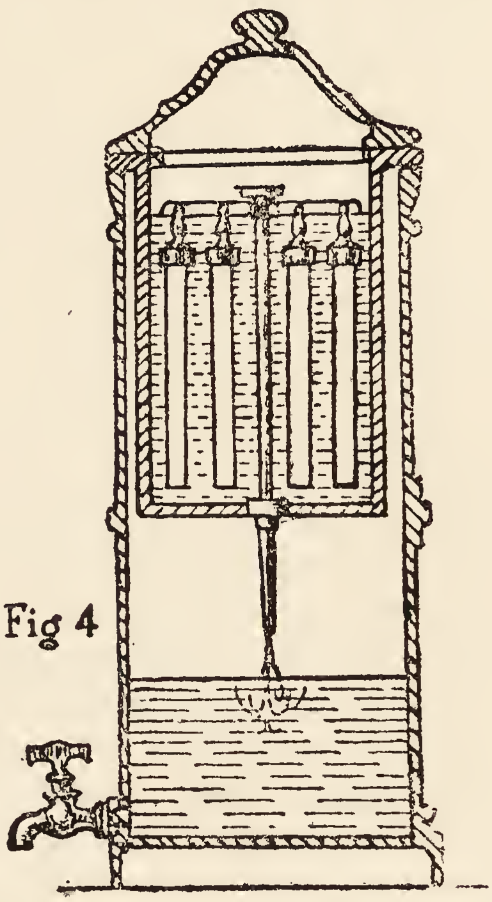


Fig 4

introduced. There are also other forms which act by the pressure produced by a vacuum which takes the place of the pressure in a service main. Although the Berkefeld filter (Fig. 3) differs from Pasteur's but slightly as regards external appearance, in the vital element of the filter—namely, the cylinder—there is an important difference. It is composed of diatomaceous earth called *Kieselguhr*, and, although it has the same external diameter, the internal cavity is very much smaller; in other words, the walls are much thicker. In appearance the material is not so smooth, it is also more porous and more brittle

To go back to Col. Johnston's experiments, he proved that the Berkefeld filter was not proof against the penetration of bacteria through its substance after periods of working varying from four to ten days, whereas the Pasteur filter during twenty-eight days continuous working with water highly charged with micro-organisms discharged a perfectly sterile filtrate.

In summing up on the whole series of his experiments, Col. Johnston writes:—"The results of the experiments have conclusively proved that the Pasteur-Chamberland filter is undoubtedly the best and the only one on which reliance can be placed for permanently sterilising drinking water."

Subsequently Col. Johnston had an opportunity of verifying the results of his laboratory experiment as regards the value of Pasteur-Chamberland filters in actual practice in the case of a water outbreak of enteric fever among the *personnel* of No. 4 General, Mooi River, Natal. Eleven days after discarding the inefficient filters and substituting a large automatic syphon action Pasteur-Chamberland filter (allowing for the period of incubation), enteric fever, which had previously been very prevalent, ceased almost altogether.*

As regards the experiments of Sir German Woodhead and Dr. Wood, practically the same conclusions were arrived at as to the value of ordinary domestic filters, and each of the twenty-one varieties tested proved quite unreliable in removing bacteria from water. Additional interest attended these later experiments, because, besides testing the power of the filters to remove organisms already present in water and introduced pathogenic organisms, sterilised water charged with the bacilli of cholera and typhoid was used. As regards the Pasteur and Berkefeld filters, the experiments of Sir German Woodhead and Dr. Wood also practically agree with those of Col. Johnston, the former being favourably reported upon and the latter unfavourably.

With reference to Col. Johnston's investigation, it is but fair to mention that the Berkefeld filter now in the market is an improvement on the older one, and has been favourably reported upon.

Sir German Woodhead and Dr. Wood also tested another form of porcelain filter—namely, the *Porcelain d'Amiante*, upon which they report favourably, only it is stated that the texture of the filter medium is so very fine that its use is only practicable as a pressure filter. In concluding their remarks, these two experimenters state:—"Before concluding we may perhaps be

* *Journal of the Royal Army Medical Corps*, April, 1905.

permitted to make a few observations regarding the testimonials and statements published by the makers of the filters (imperfect from the bacteriological point of view) which we have reported on. These filters may, as we have already said, materially increase the risk of acquiring infective disease ; but, in addition, they are to be looked upon as an unmitigated evil, in so far as they give rise to a sense of false security, which prevents the precaution of boiling the water being taken where necessary. We should recommend accordingly that the vendors should either withdraw these statements, or at the very least satisfy themselves, by taking independent expert evidence, that they are justified in making these claims in regard to the prevention of disease by the use of their filters." So much then for the recent experimental data upon which, in this country, all ordinary domestic filters have been unfavourably reported upon, and in other countries similar conclusions had previously been arrived at, in support of the conviction which has long been entertained by sanitary experts as to the danger of relying on such filters as safeguards against water-borne diseases. We are not solely dependent, however, upon trial experiments for our conclusions, for the statistics of the French army unmistakably confirm these. Since the Pasteur filter was used in the French army typhoid fever in the Paris barracks has been reduced more than 25 per cent., and throughout the whole army over 50 per cent. Again in 1892, M. de Freycinet, in reporting a still further reduction, says :—"Wherever the Pasteur filter has been applied to water previously bad, typhoid fever has disappeared."

It was in 1888 that the Pasteur filter was first introduced into the French army, in the hope that it would be instrumental in diminishing the annual prevalence of typhoid fever among the troops. Previous to its introduction, the average annual number of cases in the army amounted to 6,881, of which number 1,270 occurred in the Paris barracks. In the year after the introduction of the filter the progressive and rapid decline in the number of cases began.

In 1892, Dr. Barthelemy, who had medical charge of the troops in the French expedition into Dahomey, reported that the use of the Pasteur filter afforded absolute protection against dysentery, as was proved by the fact that the disease attacked the soldiers whenever the use of the filter was discontinued.

Our own army authorities are now fully alive to the significance of these facts. Until quite lately, however, the filters used in the British army belonged to the class of filters which have just

been criticised so unfavourably, and far from their being reliable in affording protection against water-borne diseases, it is highly probable that they added to the danger. In support of this contention, Sir German Woodhead and Dr. Wood write:—"We must accordingly conclude that the danger to the individual is immensely increased by spreading the dose of cholera over a more prolonged period, as in this way the material may be ingested at a moment when the conditions are favourable for their escaping the action of the gastric juice, and thus entail the possibility of the production of the disease; while the diminution in the number of organisms ingested involved in the distribution of the dose over a longer period probably exerts no influence on the risk of infection or the gravity of the disease which is set up. This danger of all imperfect filters, when once infected with a disease organism, of continuing to infect the water for a more or less varied period is most marked in the case of pocket filters, as when these have once become infected the disease germ may be carried for indefinite periods from place to place." *

One virtue possessed by the Pasteur filter and others of the same type has not yet been mentioned—namely, that when they require cleansing, attention is at once called to the fact owing to the flow of water becoming slower and slower. The cleansing process is a very simple one, as the cylinder or cylinders, which can readily be removed, have merely to be brushed under a water-tap, to free them from the slimy deposit which collects on their outer surface. From what has been stated, the reason of the omission of a detailed description of the more common filters in the market will be understood. Doulton now manufactures a filter of the Pasteur type which is quite reliable.

Dr. Rideal and Dr. Louis Parkes, as the outcome of joint investigations, have recommended the use of bisulphate of soda (15 grs. to the pint) as a practicable and efficient means of sterilising water. This method was used during the South African war, but with what success has not been made known.†

Sir German Woodhead has shown that water which has been freed from grosser organic pollution by ordinary filtration may be sterilised by chlorine, added in the form of bleaching powder (chloride of lime) in such small quantity as not to impart any taste to the water. In the case of the Cambridge water he sometimes found that 1 part of "available" chlorine in 7,000,000 sufficed. This method of sterilising water after rough filtration

* *British Medical Journal*, Nov. 10, 1894, p. 1058.

† *Trans. of the Epidemiological Soc. of London*, vol. xx., 1900-1901.

is now extensively used in the army under regulations which set forth, in detail, the means to be adopted to ascertain the amount of bleaching powder necessary to be added in each case. This is done by adding the bleaching powder in increasing strength to the water in, say, four 1-pint mugs, and, after thorough mixing, adding to each a tablet of potassium iodide followed by a tablet of starch. When a blue colour appears in any of the mixtures it signifies that the proper amount of chlorine to sterilise the water in question has been added, and that determines the amount of bleaching powder required for a given volume of water.*

Boiling is an excellent safeguard, and inspectors should encourage the public in cases where suspicious water must be consumed to boil it, say for five or ten minutes, before using.

Taking Samples.—It is hardly necessary to say that the bottle in which the sample is taken, which should be a Winchester quart, must be scrupulously clean; before being filled, it should be rinsed out two or three times with the water that is to be analysed. The bottle ought to have a glass stopper, and it is well to cap it with leather, the string being sealed with sealing-wax. If for any reason a stoppered bottle cannot be obtained, an ordinary cork may be used, but it must be a clean new one, and it also ought to be capped as described.

The following particulars, when applicable, ought to accompany each sample :—

1. Date on which the sample was taken.
2. If from well, stream, town supply, or other source ?
3. If from well, how deep, approximately ?
4. What is the distance from the nearest midden, drain, or cesspool ?
5. How far from stable or farm-yard ?
6. Any other possible source of pollution ?
7. Is the water drawn from pump or tap ?
8. If from a pump, is it one of wood, iron, or what ?
9. If from a tap, are the pipes of lead, iron, galvanised iron, or are they otherwise specially protected ?
10. Special reason (sickness, etc.) for requiring analysis ?
11. Any other particulars to which it is desirable that attention should be called ?

In collecting samples of water for bacteriological examination,

* For a detailed description of the process to be followed, see "Sterilisation of Water Supplies for Troops on Active Service,' by Sir German Woodhead, *British Medical Journal*, Sept. 19th, 1914.

it is, of course, essential that the bottles shall be sterile—that is, absolutely free from bacteria. To ensure this, it is well to obtain the bottles from the bacteriologist who is to make the examination. Also, the samples should be packed in ice and forwarded without any delay, because, at ordinary temperatures, any organisms which may be present will rapidly increase in number, and, as the number present in a given volume (especially if they belong to the intestinal group) is the index of purity, it is important that such tendency to increase should, as far as possible, be prevented.

To the question whether the purity of a water can be roughly determined by a simple test applied by the inspector on the spot, a negative reply must be given.

Inspector's Duty with regard to Water-Supply.

Among the numerous duties an inspector is called upon to perform, there are none to which greater importance can be attached than that of enquiring as to whether the conditions upon which a pure water-supply is dependent are violated. These conditions vary in accordance with the nature of the supply. In the case of large urban districts with public water-supplies, the enquiry, so far as the inspector is concerned, will be directed mainly to the house connections, while in rural and small urban districts, which are dependent upon local supplies from wells, springs, etc., the chief circumstances to be noted are the house surroundings.

Summary.—From what has already been said, the details which in each case should receive attention will be appreciated, but perhaps it may be well to repeat the more important of these, by way of summary.

1. That the water-supply of a household ought to be within a convenient distance, *plentiful* and *pure;* but that if from any cause the supply should be limited, the smallest quantity admissible for houses without water-closets, is 4 gallons per head per day, an amount, however, which would not admit of perfect cleanliness, or proper flushing of the drains.

2. That upland surface water and water from springs and deep wells is usually of good quality, while that from cultivated land, rivers, and surface wells must be viewed with suspicion.

3. That the spot selected for a well ought to be at the highest point of the site, and as far removed as possible from all sources of pollution; also, that the well should be so constructed as to

be absolutely impervious to surface pollution, by building the brickwork in cement, sealing the surface with stone slabs, and attaching a properly constructed pump.

4. That in the case of deep wells, the brickwork ought to be built in the same manner, at any rate down to the impervious stratum of clay or rock.

5. That in all cases in which surface leakage is suspected, the well ought to be opened and examined.

6. That while storage in a house is objectionable, in cases in which it cannot be avoided, the cistern should be constructed of a material which will not impart any injurious matter to the water, and be placed in an accessible situation, to facilitate inspection and cleansing. It should be covered, ventilated, and have an overflow into the open, apart from any drain. The supply-pipe to the closet ought to be intercepted by a second small cistern.

7. That the supply ought to be constant, and that, except in special cases, the charge ought to be by rate.

8. That lead pipes cannot always be used with safety.

9. That although the water may be perfectly clear it does not follow that it is not dangerously polluted.

10. That many of the filters in the market cannot be trusted to render harmless any disease-poison the water may contain.

11. That all filters require cleansing.

12. That nothing of an organic nature ought to form part of a filter, and that it should be so arranged that it can be taken to pieces with ease.

CHAPTER III.

VENTILATION AND WARMING.

Pure air is as essential to health as pure water, although the public are very ignorant of the fact. Unfortunately, the air of our rooms may be loaded with impurities without any visible sign being apparent that such is the case, and although, fortunately, some of us have timely warnings of evil, in the shape of headaches and feelings of depression, others seem to possess an unfortunate immunity from any such indication of danger. Probably children helplessly suffer in like manner, but, reared in homes almost hermetically sealed against the entrance of fresh, or the exit of foul air, to be transferred later in life, for certain periods of the day, to schools and workshops that too frequently may be similarly described, their constitutions, if they withstand the strain that is thus placed upon them, become blunt to all impressions—nature ceases to sound the warning note which for so long has been disregarded.

Although, to the uninitiated, it would appear that air does not come into such direct contact with our internal economy as water, this is a mistaken notion. We inhale in the course of twenty-four hours, while at rest, 480 cubic inches per minute (twice this amount or more when at work), which is brought into intimate contact with the blood in the microscopical cells of the lungs, around which the blood-vessels ramify. It is here that the air performs its function by giving up oxygen to the blood, and receiving from it moisture and various effete matters. The number of air-cells has been estimated at between 5 and 6 millions, with a combined area of from 10 to 20 square feet.

These figures will give some idea of their minute size, and of the extent of the absorbent surface presented to the air.

The presence of impurity in water is in some cases indicated by its turbid appearance, but the air of our rooms, however impure it may become from overcrowding, presents no visible evidence of the fact.

The composition of the atmosphere varies in different situations. In the following table the proportions of the various ingredients of an average sample are given :—

Composition of Atmospheric Air (*Parkes*).*

Oxygen, ...	209·6 per 1,000 volumes.
Nitrogen, ...	790·0 ,,
Carbonic acid, ...	0·4 ,,
Watery Vapour, ...	varies with temperature
Ammonia, ...	trace.
Organic matter (in vapour or suspended,—organised, unorganised, dead or living),	Variable.
Ozone, ...	Variable.
Salts of Sodium, ...	Variable.
Other mineral substances, . . .	Variable.

Oxygen is the all-important element. It is the gas to which the air owes its purifying power, and it is the great supporter of combustion. If the proportion present were much diminished, a light would cease to burn, and life would become impossible.

Ozone is another form of oxygen, possessing similar, but more active properties. As a rule, it is only to be found in the purest atmospheres, and is absent in populous districts.

Nitrogen acts as a diluent of oxygen, which, in its pure state, is far too potent. Unlike oxygen, it does not support combustion, but, like carbonic acid gas, if present in excess, it extinguishes a light.

The quantity of **carbonic acid** present varies from ·2 to ·5 part per 1,000 of out-door air; the former may be the proportion in mountainous districts, and the latter in some densely populated parts of towns.

In rooms without proper ventilation, ten times the above amount of carbonic acid may be present, but although large quantities of this gas are discharged into the atmosphere as the result of the combustion of coal, respiration, etc., the quantity present in the air varies very little, owing to the diluting action of the winds, and the power possessed by plants of absorbing and appropriating the carbon.

In addition to carbonic acid, although it has not been proved chemically, no doubt **organic matter,** the result of tissue waste, and also **impure vapour** are given off from the lungs and skin and cause injury to health. Carbonic acid in itself may be present in considerable quantity without any ill effects being apparent, as is demonstrated in the case of workers in aërated water manufactories. It has been ascertained by experiment,

* A new gas, *argon*, discovered by Lord Rayleigh, and another, *helium*, must be now added to the above list. Their significance in a hygienic sense is not at present known.

that the ratio of carbonic acid added to the air *as the result of respiration*, corresponds very closely with the impurity from the same source, as judged by the sense of smell, and for this reason it is taken as a standard of purity. It is, no doubt, the presence of effete organic matters from our bodies that causes the disagreeable odour and sensation of stuffiness experienced in occupied rooms that are unventilated.

In addition to impurity the result of respiration, the air is liable to be contaminated by materials, both solid and gaseous, from a great many sources. Among the former may be mentioned particles of dust of all descriptions, too numerous to mention, pollen of plants, germs of various sorts (including, it may be, some that we know to be instrumental in the production of disease), and fragments of carbon and tarry matters from the imperfect combustion of coal. Among the latter are special gases evolved in certain trades, and others the result of combustion, as well as effluvia from badly constructed sewers, and from collections of excreta, manure, and refuse of all descriptions.

The use of gas in rooms and factories adds greatly to the impurity of the air. One cubic foot of gas will, in burning, consume the entire oxygen of 8 cubic feet of air, and also impart certain noxious compounds of sulphur and carbon to the air. In spite of this, we find that people not only use gas for lighting purposes, but also, in the shape of a naked flame, as a means of heating rooms, shops, and factories. An oil lamp with a good burner will consume 3·2 cubic feet of oxygen in an hour, so that, it may be said that one gas burner of ordinary size is ten times worse, as regards the injury it does, than a lamp giving an equal light.

From what has been stated, it will not appear surprising that the air of towns should compare unfavourably with that of country districts; the wonder is rather that the difference is not greater, and this can only be explained by the purifying power possessed by the oxygen of the air itself, and the action of the winds in distributing the impurity over a large area; it is important, therefore, that the former should not be overtaxed, and that the latter should have full play.

Diseases Produced by Impure Air.

Experiments by Dr. Leonard Hill also bear out those of Dr. Haldane. By a series of tests as to mental activity under different atmospheric conditions he has shown that, within limits, even

in crowded rooms, efficiency depends upon conditions which conduce to the non-retention of heat within the body; in other words, when the temperature and moisture are low. Moreover, he also shows that both comfort and efficiency may be maintained, even in a relatively moist atmosphere, so long as steps are taken to keep the air in movement and thus encourage surface evaporation.

The value of these experiments, even in the absence of chemical proof of the fouling of the air apart from the index afforded of this fouling by the amount of carbonic acid present in the room atmosphere, is the confirmation of the extreme importance from a health point of view of free ventilation.

Also, there can be no question that foul air is highly conducive to a general lowering of the vital functions, which renders illness more frequent, and recovery more uncertain and prolonged.

The trend of opinion recently has been to attach the utmost importance to the quality of the air of rooms and workshops, as indicated by the amount of moisture present. Dr. Haldane especially has conducted careful observations, which satisfied him that high dry-bulb temperatures may be compatible with comfort, but that when the wet-bulb temperature approaches 70° F. the injurious effect becomes at once apparent.

Enough has been said to indicate the importance of fresh air. We must now pass on to consider the amount that is necessary, and the means at our disposal for obtaining a proper supply.

Quantity of Air Required.

As the amount of carbonic acid gas present in the air of a room corresponds with the degree of impurity caused by effete matters given off from our bodies, that gas, as already stated, is taken as a standard in estimating the condition as regards ventilation. Up to a certain point, one can detect different degrees of impurity by the sense of smell, and the sensation of stuffiness experienced on entering a room from the open air, but the power of discrimination as to degree ceases after a certain amount of foulness is exceeded. The figures in the following table, prepared by Dr. de Chaumont, and which have been carefully tested, indicate the point at which impurity becomes first apparent to the senses, and also when the power of discrimination as to degree of impurity ceases.

It is not desirable to burden the memory with many figures, but, from a ventilation point of view, it is important to remember

that when respiration has added 0·2 vol. of carbonic acid per 1,000 to the air of a room, the effect begins to become apparent to the senses; consequently, it may be concluded that an amount beyond this is inconsistent with a properly ventilated room.

It must be remembered that these figures do not represent the actual amount of carbonic acid gas present in the air, but only that which is *added*, so that from 0·3 to 0·4 (the amount naturally present in the air itself) must be added in each case to show the total amount. This applies also to the remarks that follow.

The amount of carbonic acid given off per hour by a person at rest is 0·6 cubic foot; * it follows, therefore—if the air of the room is to be kept at the above standard of purity—that 3,000 cubic feet of fresh air must be introduced for each person during that time. This brings us to the consideration of the amount of cubic space required for each person.

	1. Fresh, or not differing sensibly from the outer air.	2. Rather close, Organic Matter becoming perceptible.	3. Close, Organic Matter disagreeable.	4. Very close, Organic Matter offensive and oppressive; limit of differentiation by the senses
Mean Carbonic Acid per 1,000 volumes of air, the result of respiratory impurity,	0·19	0·41	0·67	0·91

Cubic Space Required.

It is obvious from what has been said that the question of space is one which is entirely dependent upon the facility that exists for changing the air of a room, and, granting the possibility of doing so to an indefinite extent, it becomes quite immaterial how limited the space allowed for each person may be. Were it not for one consideration, this theory would be perfectly applicable in practice, but it is found to be unworkable on account of the draughts that result from the rapid movement of the cold air.

Temperature, then, influences the pace at which air may travel without causing a feeling of draught. Air at 55° to 60° Fahr.

* This is an average—men give off more, and children less.

travelling at $1\frac{1}{2}$ feet per second is not perceptible, at 2 to $2\frac{1}{2}$ feet it is imperceptible to some persons, at 3 feet it is perceptible to most, while at $3\frac{1}{2}$ feet it is perceptible to all, and anything above this causes a feeling of draught. If the air be warmed to 70° Fahr., a greater velocity is not perceived, but if the temperature be as high as 90° Fahr., it again becomes more perceptible; this also happens if it be lowered, say to 40° Fahr.

Comparatively recently it was believed that, in this country, all that could be borne was a change of the air of a room three times an hour, and therefore that, in order to retain the standard of purity—viz., 0·2 of added carbonic acid gas, as each person contributes 0·6 cubic foot of the gas per hour—the space allowed per head should be 1,000 cubic feet. In practice, this amount is very seldom met with; indeed, in cottages it too often does not exceed from 200 to 250. The amount required for barracks is 600 cubic feet, and for common lodging-houses 300. With intelligent provision for ventilation and warming, however, it is now found that the air of a room may be renewed more frequently than three times an hour without causing draught.

Theoretically, from the amount of impurity added to the atmosphere by **animals,** such as horses and cattle, the amount of space required by them, on the above calculation, would be from 3,000 to 7,000 cubic feet, but this amount in their case is neither requisite nor attainable. The conditions are altogether different, as much greater liberty may be exercised in the direction of free ventilation. In practice, 1,000 cubic feet per head is a satisfactory amount. The Regulations under the Dairies, Cowsheds, and Milkshops Order usually require 800 cubic feet, although in some cases the amount is only 600, or even less. As a matter of fact, it has been proved that cows may be kept practically in the open air without injury to themselves and without interfering with the yield and quality of the milk, so that, given the necessary floor-space and free ventilation, cubic capacity becomes a secondary consideration.

Fallacy concerning Large Rooms.—It is a popular idea that plenty of space does away with the necessity for ventilation, but this is a mistake. Even with a space of 10,000 cubic feet occupied by one person, in the absence of ventilation, the limit of impurity would be reached in a little over three hours, after which time the same amount of fresh air would have to be introduced as in the case of a smaller room, in order not to exceed the standard of impurity.

The **height of a** room is an important consideration in a venti-

lation enquiry. The respiratory impurities tend to accumulate about the occupants of the room, and beyond a certain point *loftiness will not take the place of floor-space.* The air of a space enclosed by high walls, but uncovered by a roof, would soon become very foul if the space were overcrowded. There is no objection to a lofty room, but it must be remembered in estimating the capacity in a ventilation sense, that a height of 12 to 13 feet only should be considered, as this may be taken to be the maximum useful height of a room.

Ventilation and Warming of Schools.

The question of the ventilation and warming of schools is a difficult one, because of the small cubic space provided per scholar, and, therefore, the need for changing the air of the class-rooms more frequently than is compatible with the absence of draught. This difficulty has been enhanced by the introduction of a type ot building (central-hall type) in which the class-rooms are grouped round a central hall, an arrangement which does not allow of cross-window ventilation. It is difficult to understand how such a type of building, which is practically a back-to-back house, ever came to be approved of, but the probability is that supposed administrative advantages were allowed to outweigh other considerations. Be this as it may, the unfortunate result is—there are throughout the country numerous large and costly buildings of this type in which the conditions as regards ventilation are deplorable. It is true that, in some cases, the difficulty is more or less overcome by the costly expedient of mechanical ventilation, but, apart from other objections, this affords a shocking object-lesson to the children, who thus, from day to day, never see an open window, a consideration which is all the more important now that an attempt is being made to teach elementary hygiene in schools.

The Staffordshire Education Committee introduced some years ago an improved class of building ("Staffordshire Type") in which a detached central hall is provided, the class-rooms being arranged in pavilions with verandal communication, thus allowing of free cross-window ventilation. Many schools of this type have been built, and it is now generally admitted that, from an administrative point of view, they are as efficient as the central-hall schools.

The heating is effected by means of low-pressure water circuits with ventilating radiators, and free cross ventilation is

Mean Respiratory (added) CO_2 in Vols per 10.000

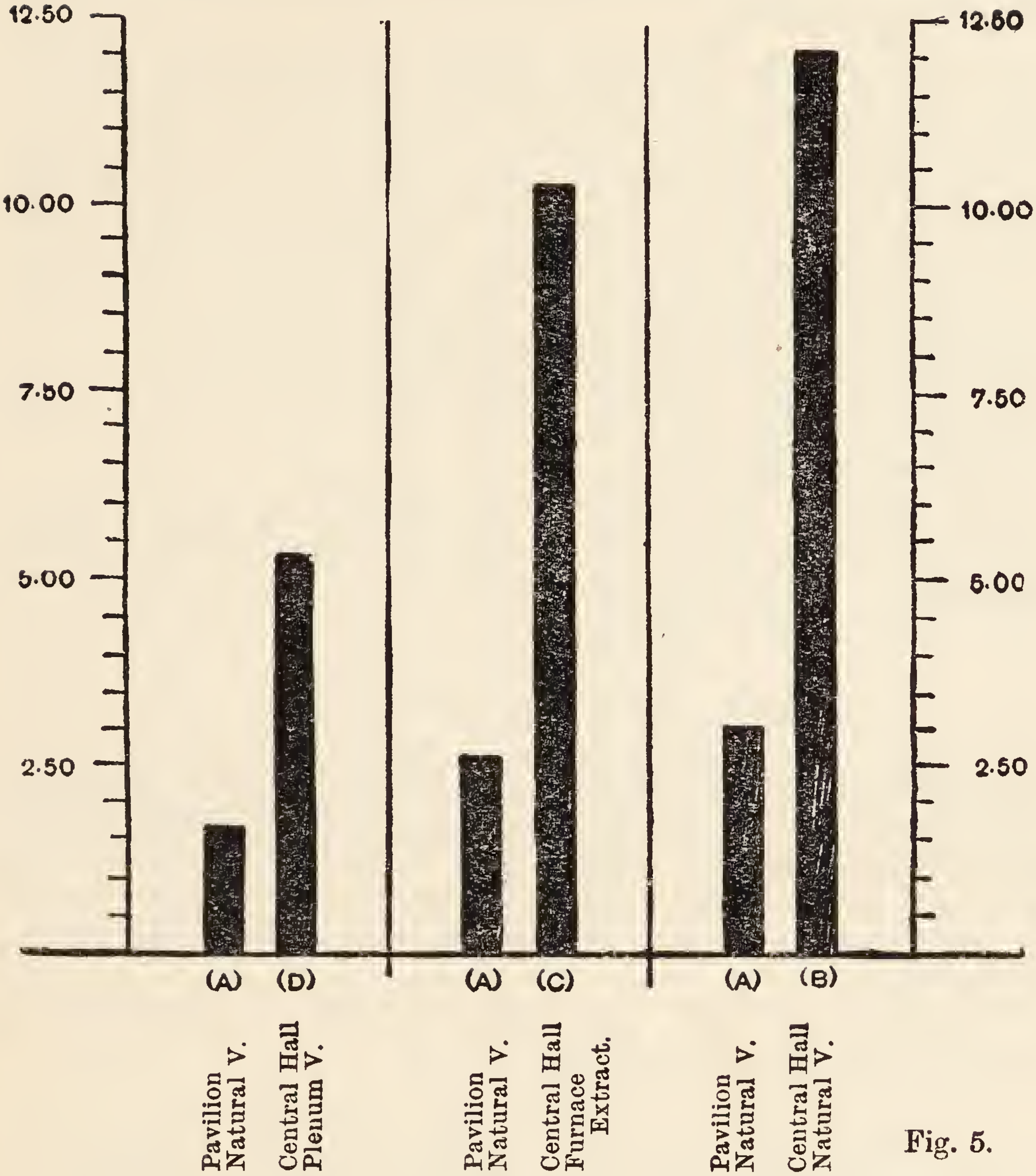


Fig. 5.

	Ventilation Opening per Child.	Air Changed in
	Sq. Ins.	Minutes.
Pavilion school, ...	29·6	10
Central-hall school B, ...	41·6	22
,, ,, ...	22·2	40
		Hours (?)
,, ,, ...	13·2	3

obtained by window hopper openings of a type which is described later (p. 60), no ceiling ventilators, so-called, or ventilating shafts being provided.

The author has conducted certain experiments in order to determine, by means of smoke tests and observations as to the amount of carbonic acid gas present in the air of the class-rooms, how this type of building compares with the central-hall type (both with and without mechanical ventilation), and the results are shown by the diagram (Fig. 5), which represents the means of a series of records obtained on corresponding days and after the same periods of continued occupation of the rooms.

It will be noticed how much superior the pavilion school records are to the central-hall school ones, even when the latter are mechanically ventilated.

The results of the smoke tests as regards the pavilion school, and the naturally-ventilated central-hall school under different conditions as regards area of ventilation openings, are set forth in the table on the preceding page.

Measurement of Cubic Space.

The estimation of the capacity of a room of ordinary shape is a simple matter, all that is necessary, in an empty room without angles, projections, or recesses, being to multiply by each other the length, breadth, and height. It is more convenient to express the measurements in feet and decimals of a foot than in feet and inches.

The following table gives approximately the proportion in decimals that inches bear to feet :—

Inches.	Decimal Parts of a Foot.	Inches.	Decimal Parts of a Foot.	Inches.	Decimal Parts of a Foot.
12	1·00	8	0·67	4	0·33
11	0·92	7	0·58	3	0·25
10	0·83	6	0·50	2	0·17
9	0·75	5	0·42	1	0·08

For example, if a room measures 12 ft. 6 in. in length, 10 ft 3 in. in breadth and 10 ft. in height, the calculation will be as follows :—$12{\cdot}5 \times 10{\cdot}25 \times 10 = 1{,}281$. The capacity of the room in question, then, is 1,281 cubic feet.

Any recesses that exist must be measured separately, and added to the total; and projections, in the shape of walls or cupboards, must be deducted from it.

In the case of rooms of irregular shape, it is necessary to measure portions separately, in order to arrive at the true capacity.

The following are the rules to be followed in the examples most frequently met with :—

Area of a triangle = base multiplied by half the height.

Suppose, in the figure given (Fig. 6), the base measures 12 feet and the height 6 feet, the area would be 36 feet. This rule applies in the case of rooms without ceilings; the section of the space within the slope of the roof, representing the triangle, is measured by multiplying the breadth of the room (base of triangle) by half the height from the roof angle to a line corresponding with the height of the walls, and this figure multiplied by the length of the room will give the cubic capacity of that part of the space embraced by the roof slope.

In the case of a room the walls of which are irregular as to length, corresponding, for example, to the figure represented (Fig. 7), the area may be obtained by dividing the floor space into triangles, and taking the sum of their areas—this figure multiplied by the height from floor to ceiling will give the cubic capacity.

Fig. 6.

Fig. 7.

Fig. 8.

In the case of a circle, the area is obtained by multiplying the square of the diameter by ·7854, and this figure multiplied by the height of the room will give the capacity.

The area of a segment of a circle (Fig. 8) is obtained by adding the cube of the height, divided by twice the chord (a line joining the extremities of the arc of the circle), to two-thirds of the product of chord and height $(\text{Ch.} \times \text{H} \times \frac{2}{3}) + \frac{\text{H}^3}{2\ \text{Ch.}}$

The figure obtained, if multiplied by the height of the room, in the case of a circular recess, or the length of the room, in the case of a circular roof, will give the capacity of the space enclosed.

The cubic capacity of a dome is ascertained by multiplying

two-thirds of the product of the area of the base by the height (area of base × height × ⅔), the area of the base being simply that of a circle.

By applying these rules most spaces usually met with may be measured, and by dividing the total capacity by the number of persons occupying the room in question, the cubic space per head is obtained.

Ventilation.

By ventilation is meant the dilution and removal of all impurities which collect in the air of inhabited rooms. The process may be the result of forces constantly acting in nature—**Natural Ventilation**; or it may be the result of forces set in action by man—**Artificial Ventilation.**

In order to understand the operation of the various ventilating appliances in use, it is necessary first to understand the principles with which they must all comply to insure success. Although many difficulties are met with in devising ventilation schemes, these arise not so much, perhaps, from want of knowledge on the part of the person engaged, as from the impossibility of the task he is asked to perform. By the use of artificial means, a large volume of air may be passed through a room; but, as already explained, if the rate at which the air travels exceeds a certain pace, a feeling of draught is the result.

Principles of Ventilation.

The chief forces acting in nature which encourage ventilation are—(1) *Diffusion;* (2) *the action of the winds;* and (3) *the movement produced by unequal weights of air*, upon which principle the wind itself is dependent.

Diffusion is the term applied to the power which gases of different densities possess of mixing with each other. This intermixing may take place through porous substances, such as dry brick, but it is slow under all circumstances, and, therefore, it assists in ventilation only to a slight extent.

The Wind is an active agent in ventilation, but it is open to the objection that, while at one time it is practically almost stagnant, at another it may be blowing with great force, and for this reason it is difficult to regulate its effect. When the weather will admit of it, the action of the wind may be taken advantage

of, by opening windows on opposite sides of a room, as a free cross current of air will thus be produced; this practice ought invariably to be followed, at intervals, when rooms are unoccupied, for example in the case of schools, as by such means a rapid renewal of the air is effected.

The action of the wind is also of great assistance in encouraging an upward current in ventilating shafts, by reason of the aspirating effect that one current of air has when passing at right angles across another, in the manner indicated by the arrows in the sketch (Fig. 9).

The action of the wind has been taken advantage of in house ventilation by fixing movable cowls at the top of shafts, with vanes so fixed as to direct the mouth of the one towards the wind, and of the other in the opposite direction. The effect is

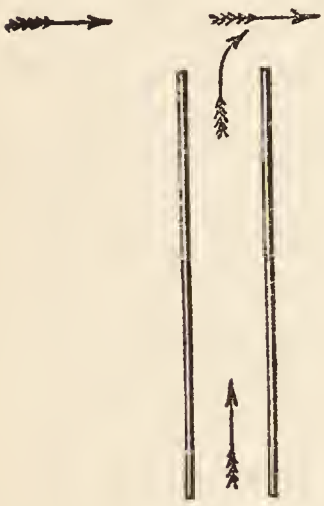


Fig. 9

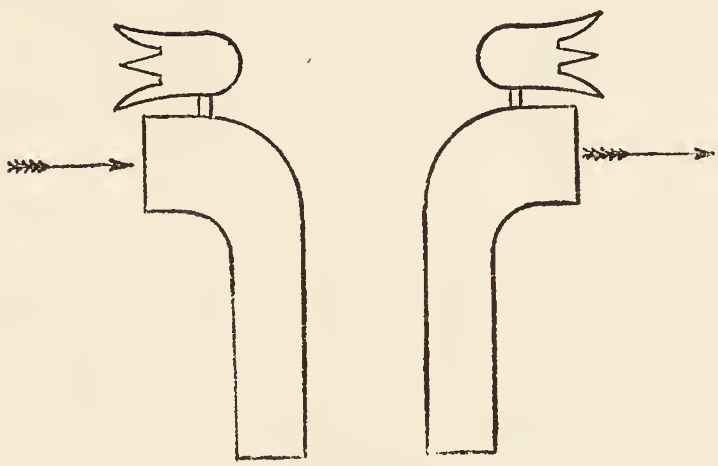


Fig. 10

that the wind enters the cowl which has its mouth turned in the direction in which it is travelling, when it can be conducted by pipes to the various rooms, and returned to the reverse cowl by other pipes (Fig. 10).

So far as house ventilation is concerned, this plan has not been found to answer, as the great variation in the pace at which the wind travels renders it difficult to regulate the amount of air introduced. The system answers well, however, in the case of ships, where the cowls can be adjusted, by hand, in a position in accordance with the rate at which the ship is travelling, and the direction of the wind.

The movement produced by **unequal weights of air** is a potent factor in ventilation, particularly in our climate, where the external air is, as a rule, colder than that of our rooms. It

operates in the following manner:—When the temperature of a room is raised, the air in it expands, and, by reason of its increase in volume, the room cannot contain the same quantity as before, a portion, therefore, is discharged through any opening that may exist. But if the outside air is not correspondingly raised in temperature, an inequality is at once established between the one and the other; and as the cold air outside is heavier than the warm air inside, the result is that, by the law of gravitation, it will enter the room through various openings, and continue to do so until such time as the point is reached when the temperature of the one and the other (and, therefore, their gravity or weight) is precisely the same. Now, if the cause which led to the raising of the temperature of the inside air continues to operate, either in the shape of a fire, or other artificial heating means, or by reason of the room being occupied by people, the same constant inflow of colder air will continue, and the rate of entrance of this cold air will be exactly in accordance with the depth of the heated column, and the difference of temperature between the one air and the other. The greater the depth of the heated column, and the greater the difference between the two temperatures, the more rapid is the inflow. It does not follow that the direction of the current is always from the outside into the room, because if from any cause the air of the room is colder than the outside air—which it may be in summer—the reverse action takes place. In winter, when our houses are artificially warmed, this process is in active operation, and if the direction of the inflowing current of cold air be regulated by artificial appliances, it may be turned to excellent account as a means of ventilation, as will presently be explained.

Under ordinary circumstances, if rooms are not overcrowded, and it is not, therefore, necessary to change the air very often, natural ventilation is sufficient, but in the case of crowded public rooms some artificial means of renewing the air ought to be employed. There are two systems of artificial ventilation—viz., *Extraction* and *Propulsion*. By the former system the foul air is extracted from the room, and is replaced by pure air; and by the latter, pure air is forced into the room, the foul air giving place to it. Of course, a system of artificial ventilation is not practicable for private houses, and can only be entertained in the case of factories and public buildings.

The various appliances in use in both natural and artificial ventilation will presently be described.

Position and Size of Openings.—It is obvious that, in order that air may enter a room, an exit must be provided for that which is at present in the room, so that two openings are necessary. Theoretically, the size of the outlet ought to be larger than that of the inlet, because warm air has a greater volume than cold; but the difference is so slight that it may be disregarded, and both openings may be of the same size.

Again, although the total area of the inlets ought to correspond with that of the outlets, their number should be greater, and they should be placed in situations as far as possible removed from the outlets, so as to ensure as complete a circulation of air as possible. If they are placed close together, the air will enter and pass out without mixing with that of the room, and so the object for which they are intended—viz., the dilution of the impure atmosphere—will not be accomplished.

Warm air, being lighter than cold, has a tendency to rise, therefore the most suitable position for the outlet ventilator is in or near the ceiling; it by no means follows, however, that the proper position for the inlet ventilator is near the floor, for, were it so placed, as the air that enters is usually much colder than the air in the room, a draught would at once be felt. The position of the inlet ought to be about 6 feet from the floor, and some plan, such as will be mentioned later, must be adopted that will give the entering air an upward direction.

By this arrangement draughts are not so likely to be experienced, because, by the time the incoming air reaches the level of the occupants of the room, its temperature has been raised by mingling with the warm air to a point at which movement is less perceptible. In cases where it is possible to warm the air before it is introduced, the inlet may be at the floor level, as will be seen when we come to consider the mechanisms employed for warming and ventilating rooms.

These principles apply more especially to rooms which do not permit of cross ventilation by opposite window openings or other alternatives, in which case ceiling openings are both unnecessary and undesirable, as, for example, in the case of non-central-hall schools and hospital pavilions.

The Chimney is a very efficient outlet ventilator; and in rooms it is usually the only one. This really is an example of artificial ventilation, as its action is greatly dependent upon the fire, but, as it is so commonly found, one may almost look upon it as being natural.

Mechanisms Employed in Ventilation.

From the account just given of the principles upon which the movement of air is dependent, the action of the various mechanisms in use as aids to ventilation will better be understood. In warm summer weather ventilation is an easy matter, for then a perfect change of the air of a room may be accomplished by opening windows ; but in cold weather this cannot be done, and it becomes necessary to devise schemes for changing the air of rooms without inducing draught.

Mechanisms Employed in Natural Ventilation.

Tubes or shafts are employed as both inlets and outlets, and in their construction certain rules must be followed.

Friction greatly influences the rate at which air travels along a tube, and for this reason, especially in the case of natural ventilation, it is important to limit its effect in every possible way by reducing the causes of it to a minimum. The following are the more important considerations under this heading :—

1. That as in the case of two openings of similar area, the one circular and the other square, the friction surface in the former case is only $\frac{7}{8}$ of that in the latter, circular are to be preferred to square tubes.

2. That the smaller the opening the greater is the friction. In the case of openings of similar section the friction is inversely as the diameter. For example, with an opening of 6 inches diameter, the friction will be twice that of an opening of 12 inches ; the diameter of the one being twice that of the other. It follows from this that by dividing an opening of 1 square foot into four openings of $\frac{1}{4}$ of a square foot, the friction will, theoretically, be exactly doubled, because the respective diameters of the smaller openings are only one-half that of the larger.

3. That angles increase the friction greatly. It has been shown by experiment that a right angle will diminish the current by one-half ; so that a ventilating pipe with two right angles in its course will only have a quarter the ventilating power of a straight pipe of a similar length and calibre. This fact is very generally disregarded. One frequently finds ventilating pipes with many angles, by reason of their being carried round, in place of through, various projections.*

To modify friction from this cause as much as possible, in

* This applies very generally in the cases of soil-pipe ventilators (see p. 124).

cases in which it is absolutely necessary to deviate from the direct line, the angles ought to be well rounded and as obtuse as possible.

4. That the longer the tube the greater is the friction.

5. That the smoother the interior of the tube the less is the friction, not only on account of the diminished surface thus exposed to the air, but also because there is less chance of the accumulation of dust, which, besides being in itself objectionable, offers an additional obstacle to the current.

The length of the outlet tubes or shafts ought not to be greater than is necessary, for, in addition to the increase of friction with length, there is a danger of the current being checked entirely, by reason of the air in the tube being cooled to an extent which will render it so heavy as to overcome the upward tendency of the warm air from the room. To diminish this risk of cooling it is a common practice to place outlet shafts close to smoke flues.

Joints of ventilating pipes must be air-tight, otherwise the upward current will be greatly lessened by the entrance of cold air. Very commonly, in making such pipes, whether of sheet-iron or zinc,* the joints are formed by simply inserting one length of pipe into another ; but by this means an air-tight joint is not secured. All such joints ought to be soldered, and, in order that the integrity of the joints may not be endangered through any strain, the shaft ought to be secured by stays at frequent intervals.

One often finds, particularly in the case of schools, that outlet openings are made in the ceiling, and are not continued up by a shaft carried through the roof. In such cases an opening is usually made in the gable wall which communicates with the roof space. The effect of such a plan must be a more or less constant down-draught into the room—particularly if the wind chance to be blowing in the direction of the outer opening—which compels the permanent closure of the inner opening. In such cases, the remedy consists in attaching a pipe to the ceiling opening, and continuing it through the roof.

Wire gauze or perforated zinc is often used to cover outlet openings, so as to diminish any down-draught that may occur. This practice is to be condemned, for, although it may remedy the occasional evil, it permanently interferes with the extracting power of the shaft by greatly diminishing its calibre. A far better precaution against a down-draught being perceived is to fix a

* These remarks have reference to room, not to soil-pipe ventilators, which latter ought to be constructed of more durable material (see p. 124).

circular disc under the opening, and of larger diameter than it, within a few inches of the ceiling, as is represented in section by sketch (Fig. 11). By this means any down-draught, in place of descending upon the heads of the occupants of the room, is directed to the side.

Cowls are placed on outlet ventilating shafts with the object of (1) preventing the entrance of rain, (2) increasing the extracting effect of the wind, and (3) checking the tendency to down-draught.

1. The entrance of rain into a ventilating shaft diminishes the upward current of air, by reason of the cooling effect on the air of the evaporation which follows. The custom of damping surfaces, with the intention of reducing the temperature, is one which is generally practised; for example, the watering of the floors of larders and dairies in warm weather. The reason of the cooling which follows is explained by the fact that in the conversion of water into vapour heat is necessary, which heat is supplied by the neighbouring surfaces, with the result that there is a local reduction of temperature, the heat that has been appropriated being rendered "latent" so long as the moisture is retained in a vaporous state. Now, as already explained, the weight of a given volume of air is increased as its temperature is reduced, and applying this knowledge to the case in point, it will be understood that the weight of air in a ventilating shaft may, by a process of cooling, be so increased as to overcome the upward tendency of the warmer, and, therefore, lighter air below, and thus the shaft in question may cease to act as a ventilator. The tendency to down-draught in damp weather in the case of a chimney of a fire-place, which for some time has not had a fire in it, is a familiar example of the effect of the process just described; and if such may occur, notwithstanding the presence of a fire to encourage the draught, still more must it do so under similar circumstances in the case of a ventilating shaft which is not artificially warmed.

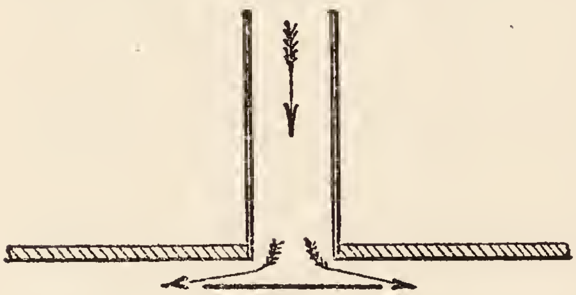


Fig. 11.

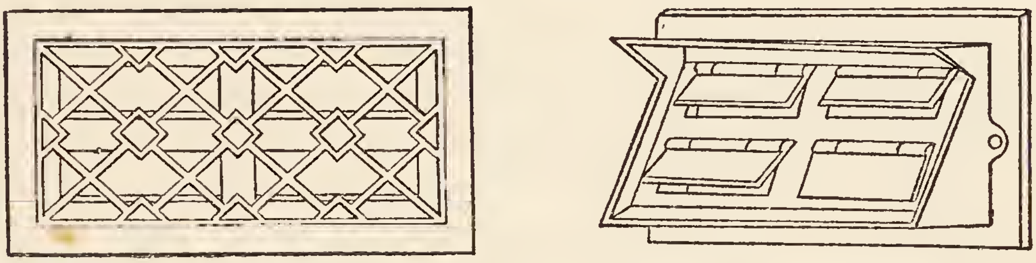
2. The aspirating effect of the wind on the air of an upright shaft is considerable, irrespective of any apparatus, but it is claimed for the various "extractors" (as their name implies), that they assist this natural tendency; experiment, however, does not fully support this claim.

3. No doubt cowls are to a certain extent preventers of down-draught, the result of downward gusts of wind.

From what has been said, it will be understood that cowls do not exercise any very wonderful power, but simply aid to a certain extent, the natural upward current that takes place through a shaft which communicates with a room, the temperature of which is higher than that outside.

The Chimney, which in itself is a powerful extractor, may be utilised as an outlet for air on a level with the ceiling, by tapping it at that point, and introducing a form of ventilator which will allow of the passage of air from the room without permitting a reverse current.

Boyle's Mica-flap Ventilator, which is represented in the accompanying sketch (Fig. 12), is designed for this purpose. Back-draught is almost entirely prevented by means of valves in the



View from room. View from chimney.

Fig. 12.

shape of thin talc plates suspended on cross-bars behind an iron-grating; these move backwards by reason of the pressure of the out-draught from the room, and are immediately closed should any tendency to down-draught—and the consequent entrance of smoke into the room—occur. A certain amount of noise is produced by the flapping of the valves, particularly when there is much wind, but apart from this objection (which is much lessened in the more recent appliances), these outlets into the chimney are of use in diminishing the tendency to draught in the neighbourhood of the fire-place, and in removing the warm air from the upper part of the room, where it is vitiated by respiration and the foul products of the combustion of gas. The flaps of outlet ventilators are now frequently made of silk in place of talc, and these may be said to be noiseless. Another improvement has been effected by means of suspending the valves so that in their natural position they are open, and are only closed by the pressure of a down draught when such takes

place. Such an arrangement is obviously advantageous, because when the valves have to be maintained in an open position, by the pressure of the air passing into the flue from the room, some loss of current must result, and, in natural ventilation especially, we cannot afford to sacrifice any little help which can be obtained from more approved appliances, however unimportant the improvement introduced may appear to be. In the case of new houses, as already mentioned, it is better to construct a second flue alongside the chimney flue, with which the upper and lower rooms may be connected, using, of course, in this case also the special apparatus.

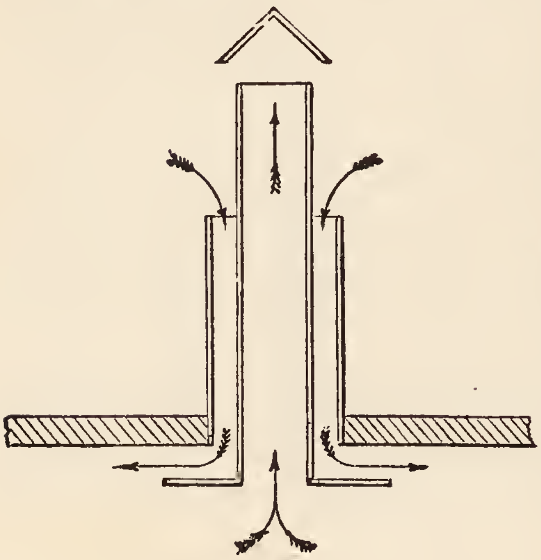


Fig. 13.

M'Kinnell's Ventilator is a combined outlet and inlet ventilator which is applicable in the case of upper rooms or rooms in single-storey houses. It consists of two tubes, the one encircling the other as represented in the sketch (Fig. 13). The sectional area of both tubes is the same, and the inner one, which acts as the outlet, is continued for some distance above the outer, and is fitted with a cowl. The lower end of the inner tube is prolonged a little distance into the room, and has a flanged rim some inches in width which extends beyond the area embraced by the outer tube, and thus prevents the incoming air from descending at once into the room, by causing it to be deflected to the side for some distance parallel to the ceiling.

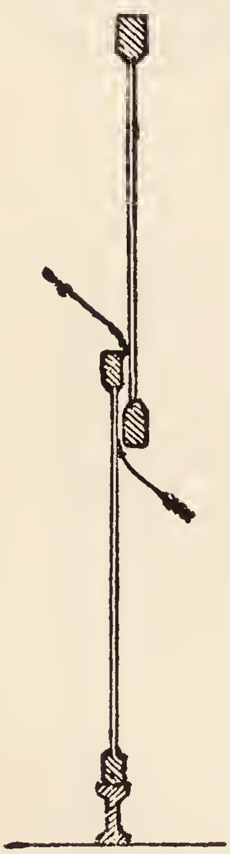


Fig. 14.

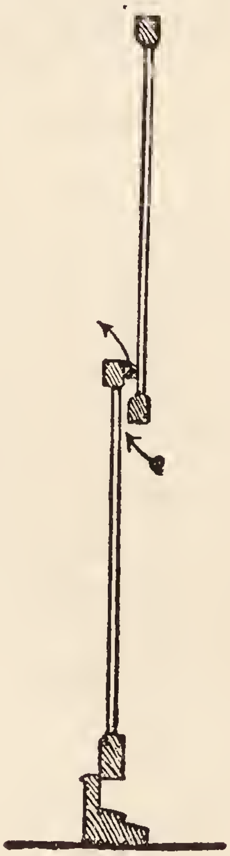


Fig. 15.

Windows may be fitted with various ventilating appliances which will admit of the entrance of fresh air without causing a draught.

Hinckes-Bird's Window Ventilator (Fig. 14) consists of a piece of wood, or what is more cheerful in appearance, plate-glass, the width of the window, and 3 or 4 inches deep, introduced under the lower sash so as to leave an opening where the upper rail of the lower sash and the lower rail of the upper sash meet. The air enters at this point, and is directed upwards by coming in contact with the elevated top of the lower sash.

A better arrangement is shown in the drawing (Fig. 15), in which the introduced bar of wood, instead of being fixed under the window sash, is placed on the inner side of it. To secure the ventilation, the window is opened to a height corresponding with the bar of wood, thus allowing a current of air to pass into the room underneath the lower rail of the upper sash as already described, and as indicated in the drawing by the arrows. The advantage of this plan is that the window can be closed when it is found desirable without removing the bar, also, the arrangement is less unsightly than the one first described. It will be seen from the drawing (Fig. 15) that the lower rail of the lower sash is deeper than usual; this is necessary in order that there shall be no space between the fixed bar and the window when the latter is closed.

By introducing a simple contrivance such as has been described, persons who raise objections to many ventilating appliances, either on the ground of cost or because of the necessity for making openings in the walls, are quite willing to go thus far in ventilating their rooms. Either plan is suited for ordinary sash windows, if, however, the one last described is the one selected it is necessary to deepen the lower rail by a few inches.

The Staffordshire School-Window Hopper (Fig. 16) is a very simple arrangement by which sash windows may be utilised for ventilation without causing draught. Connected with each window is an arrangement, shown in section, by which, when the lower sash is raised, a fixed hopper opening is formed extending across the whole width of the window, the actual extent of the opening being governed by the height to which the sash is raised. This is accomplished by means of a glass plate, 2 feet in depth, fixed to the window-sill close to the window rail, and at such an angle that the top margin of the plate projects into the room so as to leave a space of about 9 inches between it and the window, the two end angles being filled in by the frame which supports the plate.

The area of openings now being provided by this means

in the Staffordshire schools works out at 45 inches per child, if the lower sash is raised sufficiently to take full advantage of the hopper openings The height from the floor to the window-sill is 4 feet to 4 feet 6 inches, so that the top margin of the hopper opening is 6 feet to 6 feet 6 inches above the floor.

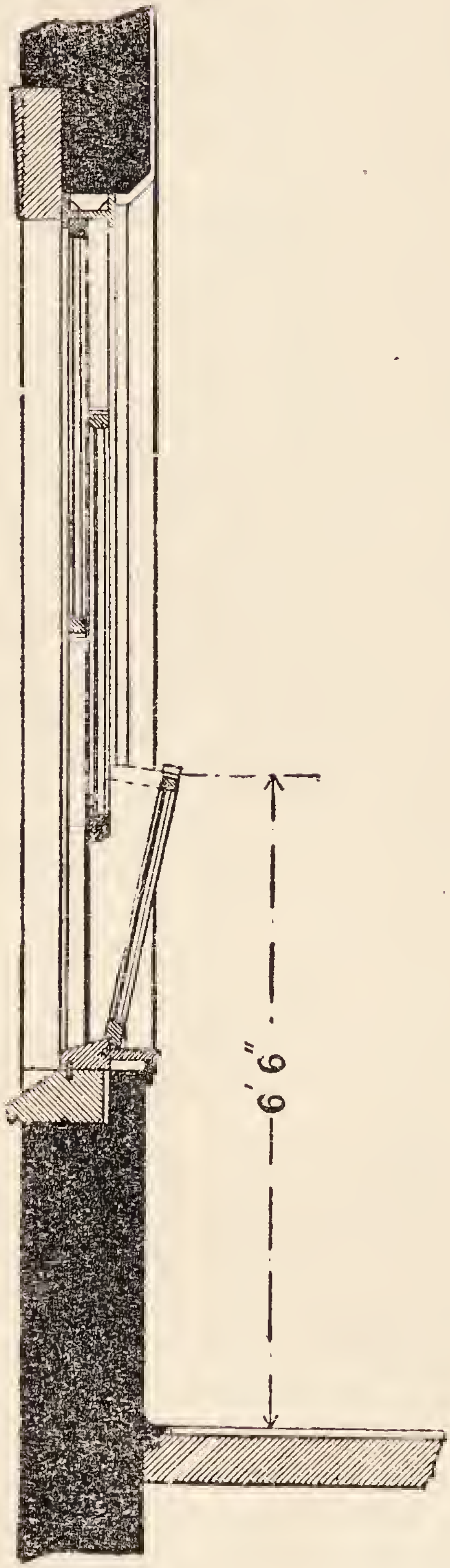


Fig 16.

To compensate for the free ventilation provided, the mean heating surface (low-pressure water) is on the somewhat liberal scale of 24 superficial feet per 1,000 cubic feet.

Louvred Panes, taking the place of one of the squares of glass, and arranged so as to admit of being opened and closed, is another, although a bad, plan of window ventilation by which an attempt is made to give an upward direction to the incoming air. Various plans are adopted of introducing air through the house walls, of which the following are examples :—

Sheringham's Valve (Fig. 17), which is frequently employed, consists of a box fixed in the wall not too near the ceiling. The air enters through an iron grating in the outer wall, and is directed upward by an inner valvular opening which is movable, being attached to the lower side of the box by means of a hinge.

The valve is opened and closed by a balanced weight, and the extent of the opening can be regulated by means of a string and pulley.

Tobin's Tube Ventilator is another type of room ventilator which is in very general use. The air, in this case, is introduced at the floor level, through an iron grating connected with a tube

which passes through the wall into the room, where it is continued at right angles up the wall to a distance of from 5 to 6 feet.

This apparatus, as an aid to ventilation, compares very unfavourably with the Sheringham valve, and undoubtedly it should be discarded. Indeed, so imperfect is it in principle, and so frequently is it fixed in a manner which adds to its imperfections that it should unhesitatingly be condemned in favour of more modern and much simpler apparatus.

The chief objection to the Tobin tube is that it is a tube, and that within it dust may collect to any extent without attracting attention. Moreover, this defect is aggravated by the existence of a valve arrangement controlled by a handle to allow of adjustment in order to regulate the amount of air entering the room. Thus an obstruction is imposed which still further conduces to the accumulation of dust and dirt and seriously interferes with any possible attempt to cleanse the tube even in the improbable event of such an attempt being made.

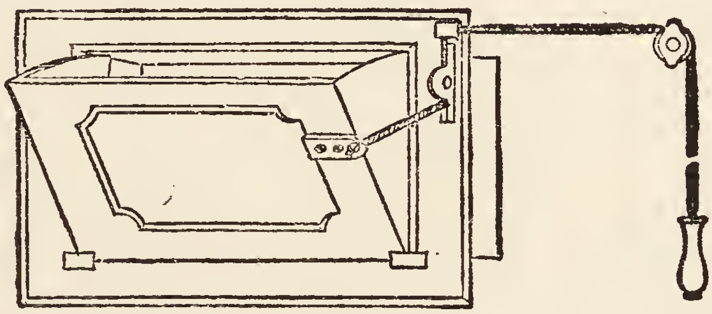


Fig. 17.

Probably the idea which led to the invention of Tobin's ventilator was the mistaken theory that the entrance of air into a room is encouraged by prolonging the opening by means of a shaft, but that this theory has no foundation in fact has been conclusively demonstrated. So long as the incoming air is deflected by its impingement on the face of a plate having an inclination upwards and inwards, as is provided for in the case of the Sheringham valve, every requirement is fulfilled. This valve in principle is, as a matter of fact, similar to the still more effective method of ventilation provided by the Staffordshire window hopper, and smoke tests have demonstrated that with such an arrangement the incoming air is caused by the hopper to take a right angle upward course, and it is not until it has followed that course to within a few feet of the ceiling that it begins to diffuse with the air of the room.

Mechanisms employed in Artificial Ventilation.

So far, the various appliances which have been described may simply be looked upon as aids to the natural tendency which exists to an interchange taking place between the outside air and the air of a room, and, up to a certain point, they are of great value; but in the case of rooms or public buildings in which the cubic space allotted to each person is very limited, and especially when cross-ventilation is impracticable, it becomes necessary to supplement the natural by some artificial means of renewing the air. There are two methods by which this may be accomplished—viz., *propulsion* and *extraction*. By the former, fresh air is forced into the room, and by the latter foul air is extracted from the room by various appliances. The method by propulsion is usually to be preferred, as the air discharged into the building may be taken from any selected situation, and directed—after treatment, it may be, by filtering, warming, cooling, or moistening—to any particular locality. There are circumstances, however, favourable to extraction being the system selected, but the advantages, under varied conditions, of the one or the other will be better appreciated after the mechanisms employed in each case have been described.

Fans consist of a series of vanes fixed in an oblique direction to a revolving axis either within a chamber or in the open, according to design. By the rapid revolution of the fan the vanes set the air with which they come in contact in motion, and thus a current is produced which passes onward at a speed which is regulated by the size of the fan and the rapidity with which it is made to revolve. These fans act as propellers or extractors, according to whether they are fixed in connection with the inlet or outlet ventilating shaft. Steam or electricity may be used as the motor power, or, what may be more convenient if the latter is not available, a gas or oil engine.

Heat is capable of being utilised as a means of ventilation by *extraction*. The assistance in this direction afforded by the ordinary fire-place, and the various methods by which it may be taken advantage of, have already been referred to, but special shafts are sometimes connected with furnaces for ventilating purposes. Mines are frequently ventilated in this manner. A furnace is lit at the foot of an up-shaft, which draws air which has entered by a down-shaft, after it has been distributed throughout the various workings. Ships are often ventilated in a similar way by the ventilating pipes from various parts of the vessel

being conducted to a shaft which communicates with the boiler furnace.

Gas used for lighting purposes may be utilised as a very efficient ventilating power, and, indeed, ought to be so utilised. What are known as sun-lights are a series of burners congregated together near the ceiling, and connected with an outlet shaft. The heat generated by the gas is thus taken advantage of as an extracting power, and all noxious fumes, the result of combustion, are at once carried away, together with a large amount of foul air from the room.

If the plan of connecting all gas-lights with outlet shafts was more generally adopted, it would add immensely to our health and comfort. In old houses it is not always easy to adopt this plan, but in new houses no gas burner ought to be fixed except on this principle.

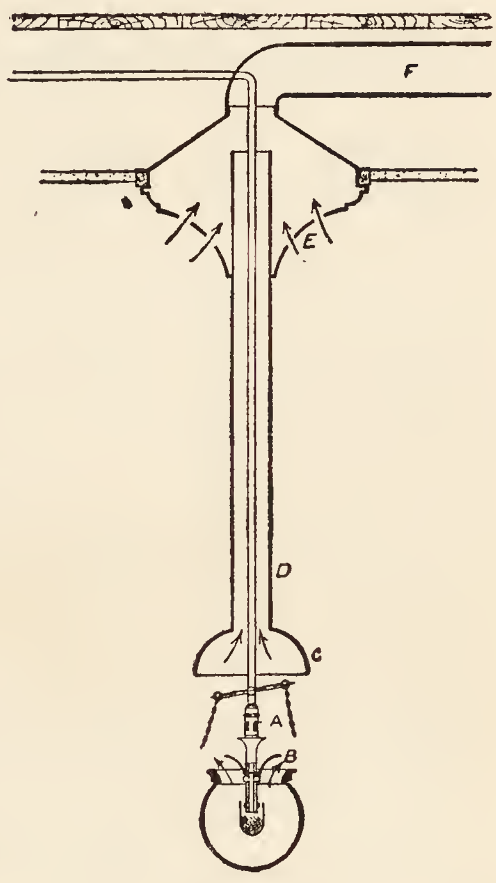


Fig. 18.

At present it does not seem that any burner is manufactured which permits of the ventilating attachments suggested being introduced, but the drawing (Fig. 18) shows how such an arrangement might be adapted to a modern incandescent burner. As indicated by arrows, the air of the room enters at the openings marked, A, to supply the oxygen necessary to improve combustion so that the heat of the flame may be sufficient to render the mantle brilliantly luminous. The resulting heat, which is considerable, causes the air to ascend through the opening of the globe, carrying with it the impure products of combustions, the current being slightly deflected by impinging on the semi-circular diaphragm B, in order to prevent the partially used up air being again indrawn at the openings, A. Overhanging the burner is a dome, C, connected with a tube, D, surrounding the gas pipe, and forming a ventilating shaft which continues upwards to a ceiling rose, through which it passes to terminate some distance above by being cut short. From the top of the chamber formed by the ceiling rose,

a ventilating shaft, F, starting with an easy bend, passes along between the ceiling and the floor above to join a flue.

It will be understood how such an arrangement would provide, not only for the removal of the impure products of combustion, but also assist in the ventilation of the room. The heated column of air in the ventilating shaft, D, would create a sufficient upward current to draw within it the foul air which had been slightly deflected by the diaphragm, B, and the heat would be sufficiently maintained at the opening of the shaft above, within the ceiling rose, to encourage the air of the room to enter through the openings of the latter, E, and continue its course to the fire flue.

Gas brackets when fixed on a wall in the neighbourhood of a fire-place may be ventilated by an overhanging pipe communicating with the flue; this arrangement need not necessarily be unsightly. In connecting such ventilating pipes, it is important to notice that the flue in question is not common to two rooms. It is by no means an unusual custom, although it is a highly objectionable one, to connect a fire-place on the first floor with the flue coming from one on the ground floor, and, under such circumstances, if the gas ventilator belonging to the down-stairs room is carried into the flue, the offensive fumes are likely to be discharged into the room above. Far too little attention is paid to the method of lighting rooms by gas.* What in itself is injurious when burned in the room as a naked flame, owing to the impurity which is added to the atmosphere as the result of combustion, may, by an arrangement such as has been described, not only be rendered harmless, but actually turned to account as an excellent aid to ventilation. In all new houses especially this fact ought not to be lost sight of.

A small jet of gas burning in an outlet ventilating shaft—apart from any consideration of lighting—will greatly facilitate the upward current of air.

Steam may, when available, be used as a means of ventilation by extraction, by being discharged in the form of a jet into the outlet shaft. By this means a volume of air is set in motion which is said to exceed by 200 times the volume of the steam.

The following is a summary of some of the chief points that have to be borne in mind in connection with ventilation :—

1. That in order to keep the air of a room within the recognised standard of purity, it is necessary that 3,000 cubic feet of fresh air should be introduced every hour for each occupant.

* For a description of various gas burners, see *Our Homes*, Chaps. xlii to xliv.—*R. Brudenell Carter.*

2 Although, theoretically, 1,000 cubic feet of air space per person is desirable, by an intelligent application of cross-ventilation when such a plan is possible, this space can be much curtailed without discomfort or inconvenience to the occupants of the room.

3. It is a mistake to suppose that cubic space can take the place of ventilation, for, however much space may be available for each person, unless the requisite quantity of fresh air be introduced, a period is ultimately reached when the limit of impurity will be exceeded. The height of a room also, beyond a certain point, does not count as space in a ventilation sense.

4. That although, theoretically, animals, such as horses and cattle, ought to be provided with a larger space than people, in practice, by reason of the greater liberty that may be taken as regards the introduction of fresh air, the actual space provided may come far short of the theoretical standard.*

5. That in every case it is necessary to provide inlets for fresh, and outlets for foul air, although in most ordinary rooms the chimney answers the purpose of an outlet.

6. That the best position for an outlet in an ordinary room is in or near the ceiling; that the inlets ought to be more numerous than the outlets, and placed as far as possible apart from them, and that they ought to be so constructed as to impart an upward direction to the incoming air.

7. That, in order to minimise the effect of friction in ventilating shafts, they ought to be large in diameter, circular in shape, smooth in the interior, and not longer than is necessary. All angles, if possible, ought to be avoided, and, where essential, they ought to be as obtuse as possible. Covering the room opening with wire gauze ought to be avoided, and as regards ceiling openings a plate fixed within a few inches of the ceiling, and of larger diameter than the opening, should be substituted, so as to direct any down-draught that may occasionally occur to either side.

8. That the entrance of rain ought to be guarded against by means of a cowl, which, also, in itself, will limit the effect of gusts of wind in causing down-draughts, and possibly assist the upward current of air.

9. That means ought to be provided for regulating the quantity of air admitted, in accordance with varied conditions of temperature, etc.

* Probably no more than 800 cubic feet can be insisted upon in "Regulations" under the "Dairies, Cowsheds, and Milkshops Order," but, after all, free ventilation is of more importance than cubic space.

10. That ventilating tubes ought to be connected with all gas lights, to remove the noxious fumes of combustion, and assist in the general ventilation.

11. That, in the case of crowded rooms, some artificial means of ventilation is necessary, and that, under these circumstances, the air before entering the rooms ought to be warmed during cold weather, otherwise a sensation of draught will be felt.

Warming.

As the question of warming is closely connected with that of ventilation, it is convenient to deal with it in this chapter.

There is perhaps no department of domestic economy about which greater ignorance is displayed than the warming of houses. Among the poorer classes, more especially, this ignorance, combined with more or less carelessness, leads to the most reckless waste in the consumption of coal, even when poverty necessitates its being purchased at the cost of considerable deprivation in other directions. The people are not alone to blame for this waste, for they are obliged to live in houses with fire-places so constructed as to afford a minimum amount of heat from a maximum amount of coal. Of recent years, in the case of better class houses, a certain amount of improvement has been apparent, but even in these we have not yet by any means seen the last of the hideous hollow-backed iron grates.

Heat may be communicated by *radiation*, *conduction*, and *convection*. The open fire-place is an example of the first, and although it is an extravagant method, with certain precautions to be presently noticed, this fault is capable of considerable modification. From a health point of view, radiant heat is certainly to be preferred to the system of heating by convection as one usually finds it carried out, for ventilation is a necessary condition of an open fire-place, and the air of the room being thus continually renewed, is not dried as it is in the case of warming by stoves or hot pipes.

On the other hand, a room cannot be uniformly warmed by an open fire-place, and draught is likely to be felt in the neighbourhood of the fire, owing to the air rushing from distant parts of the room, and from ventilators, etc., towards the fire-place. The heating effect of an open fire-place diminishes rapidly the farther one is removed from it, the loss increasing exactly as the square of the distance, so that the heat at a distance of 4 feet from the fire is sixteen times less than it is within 1 foot. Under these

circumstances, it will readily be understood that, in the case of long rooms especially, an open fire-place is not an efficient method of warming.

Conduction is the term applied to the passage of heat from one particle to another; and **convection,** to the conveyance of heat by moving masses of air. The latter is the principle which is chiefly operative in the case of rooms heated by stoves and hot-water or steam pipes, and although greatly superior to the open fire-place as a means of warming, there are great objections to the plan as one usually finds it carried out in practice; but as these objections are all capable of being overcome, the fault lies not in the principle itself, but in the ignorance of those who put it into practice. From what has been said, the necessity for reviewing the conditions of warming usually met with, will be apparent.

Open fire-places, as usually constructed, possess one or all of the following important faults:—

1. The grate is placed so far back under the flue opening, that great loss of heat necessarily takes place up the chimney.
2. The flue passes backwards and upwards from immediately behind the grate, and thus volumes of unconsumed smoke are drawn up the chimney, and much heat and coal are wasted.
3. The back and sides of the grate are constructed of iron, and there is a large space behind, which causes unnecessary loss of heat by radiation.
4. The front and bottom bars are constructed so wide apart, that the coal falls through in unconsumed pieces, and as the grate is open from below as well as in front, combustion is needlessly rapid, and therefore wasteful.

The important points to remember in the construction of an open fire-place are:—

1. That it should be brought into the room as much as possible, so that the heat may have a chance of radiating in all directions.
2. That the connection with the flue ought to be arranged so as not to cause an immediate back-draught and consequent loss of heat.
3. That fire-clay should take the place of iron as much as possible in its construction, so as to prevent the waste of heat by radiation from the back of the grate.
4. That the bars, both underneath and in front, ought to be so close together as only to admit of the smaller ash passing through.
5. That no air ought to be allowed to pass under the fire, the

space between the lower bar and the hearth being closed by a movable box for receiving the ashes.

The **ordinary iron grate** is familiar to all, and need not, therefore, be described, but with the assistance of the accompanying sketches (Figs. 19-23) the reader will be able to appreciate the advantages, both as regards heating power and economy, of fire-places constructed in accordance with the rules just laid down.

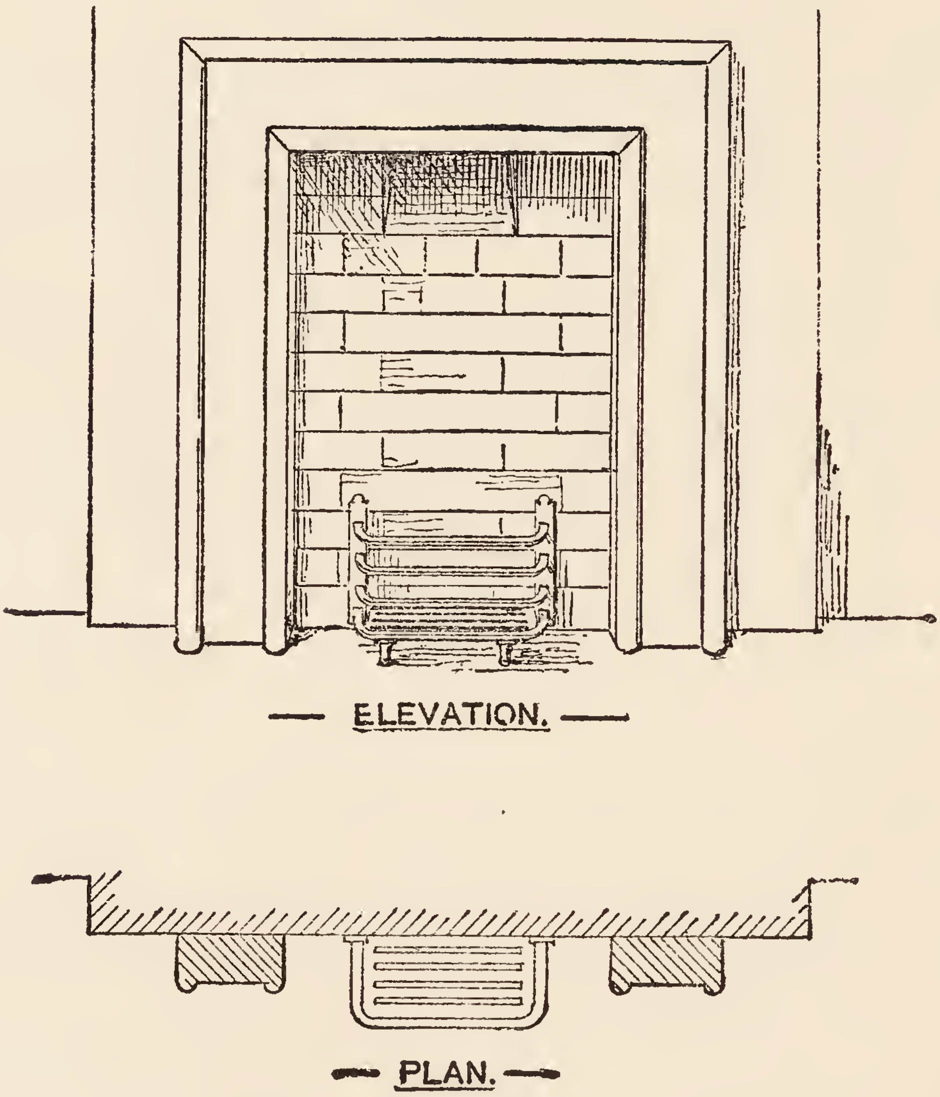


Fig. 19.

The Staffordshire fire-place (Fig. 19) is sometimes met with in old houses, although in many cases they have been abolished in favour of the modern and singularly inartistic cast-iron hollow-back grate. Where in use, the combustion and heating power is excellent, and the economy in coal, as compared with the wasteful consumption of the cast-iron grate, is sufficient soon to repay the very moderate outlay that is entailed in substituting the one for the other. The appearance presented by the plain

fire-brick sides, which to some may be objectionable, can easily be overcome by their being faced with tiles. It will be noticed that the bars project some distance in front, and thus a larger radiating surface is exposed. In the old pattern of this grate the fire stands at a distance of some 9 or 10 inches above the hearth, and the bottom bars are exposed, but by lowering the fire to within 4 inches of the hearth and introducing an ash-box with closed front, the heating power is increased, and the consumption of coal lessened.

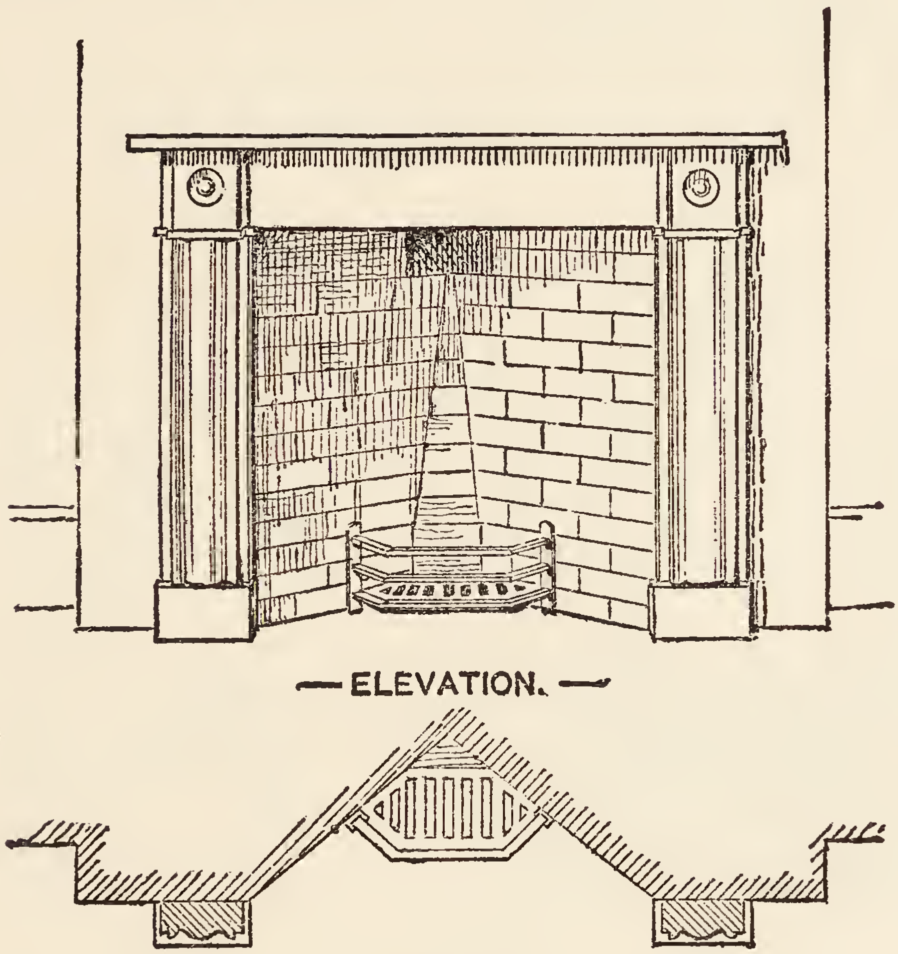


Fig. 20.

The old Leamington grate (Fig. 20) is of somewhat similar design, and, as regards heating power, it is probably as efficient. In this case the fire does not stand quite so far forward, and as the sides, which are constructed of fire-brick, form an angular opening, the apex of which is at the back, a large surface is thus exposed to the fire, and much heat is radiated into the room. It will be noticed that in both the fire-places just described, the flue starts backward at a point very nearly as high up as the mantel-shelf. The author has in many instances induced house-

holders to adopt one or other of these grates, and has usually had some trouble in convincing them that it would "draw," owing to the distance which separates the fire from the flue, but in no instance in which the suggested change has been made has the verdict been other than highly satisfactory.

The Teale fire-place (Fig. 21), which is constructed upon the principles advocated by Mr. Pridgin Teale, of Leeds, possesses all the features essential to economy and efficiency in an open fire-place. The following rules of construction are laid down :—

1. "As little iron as possible."

2. "The back and sides of the fire-places should be of brick or fire-brick."

3. "The fire-brick back should lean over the fire, not lean away from it."

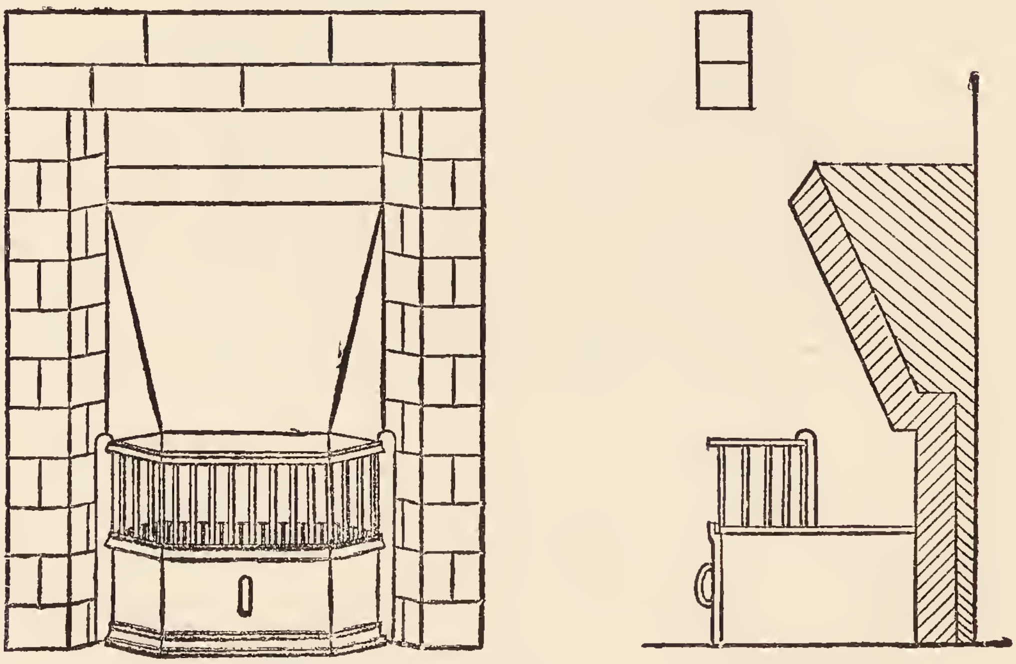


Fig. 21.

4. "The bottom of the fire or grid should be deep from before backwards, probably not less than 9 inches for a small room, nor more than 11 inches for a large room."

5. "The sides or 'covings' of the fire-place should be vertical, but inclined to one another as the sides of an equilateral triangle."

6. "The 'lean over' at the back should be at an angle of 70°."

7. "The slits in the grating or grid should be narrow, perhaps $\frac{1}{4}$ inch for a sitting-room grate and good coal, $\frac{3}{8}$ inch for a kitchen grate and bad coal."

8. "The front bars should be vertical, so that ashes may not lodge and look untidy; narrow, perhaps $\frac{1}{4}$ inch in thickness, so

as not to obstruct heat; and close together, perhaps $\frac{3}{4}$ inch apart, so as to prevent coal and cinder from falling on the hearth."

9. "There should be a rim $1\frac{1}{2}$ inches in depth round the lower insertion of the vertical bars."

10. "The chamber under the fire should be closed by a shield or 'Economiser.'"

11. "Whenever a fire-place is constructed on these principles, it must be borne in mind that a greater body of heat is accumulated about the hearth than in ordinary fire-places. If there be the least doubt whether wooden beams may possibly run under the hearthstone, then an ash pan should be added with a double bottom, the space between the two plates being filled with asbestos, 'slagwool,' 2 inches in thickness."

12. "See that no woodwork comes within 10 or 12 inches of the back of the fire."

With the assistances of the sketches, the above rules will convey a tolerably clear idea of the construction of the fire-place in question. That it is a very great improvement on the cast-iron grate, there can be no question. The great feature of it is the construction of the back. By its projecting forward over the fire, heat, which is otherwise largely lost up the chimney, is reflected back upon the fire as well as into the room, and thus, among other things, the consumption of smoke is much more perfect.*

The "Lionel Teale" Front Hob Fire-place (Fig. 22) is a more recent adaptation of the one just described. The only iron-work connected with it is that which forms the bottom bars or grid, and the ash-tray, the front bars being abolished, and the fire sunk below the level of the hearth, which is raised some 5 inches above the floor level. The air which supplies the oxygen for combustion is introduced through the front of the ash-tray, and, therefore, enters from below the fire only, and the activity of combustion is regulated by a provision for increasing or diminishing this aperture. The appearance of the raised hearth and the sunk fire is by no means unsightly. Still further economy is claimed for this fire-place, by reason of the fire being surrounded on all sides with fire-brick.

The pioneer work of Mr. Pridgin Teale has led to important developments in the construction of fire-grates, and there are now many varieties in the market which not only embody his

* For a full description of the Teale fire-place, see *The Economy of Coal in House-fires*, by T. Pridgin Teale, published by J. & A. Churchill, price 3s. 6d.

principles, but carry them even further. One of the best examples of these, made by Doulton & Co., is shown in section in the sketch (Fig. 23). It will be noticed that in this grate both front and bottom bars are omitted, the fire-well being constructed entirely of fire-brick.

Stoves, as a means of warming rooms, have their advantages and disadvantages. There is less loss of heat, and the room is more uniformly warmed. In place of the air of the room being drawn up the chimney after having been warmed by the fire, as is the case with an open fire-place, it comes in contact with the outside of the stove, and, as it is thus warmed and rendered

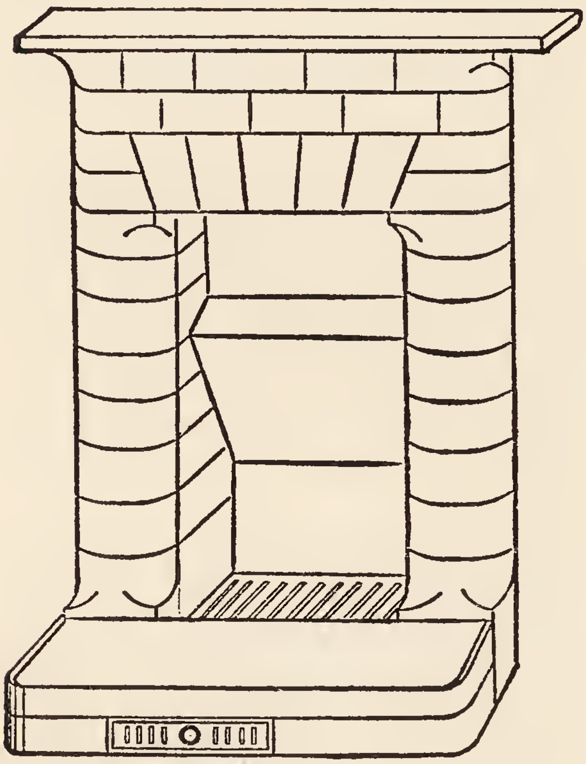


Fig. 22.

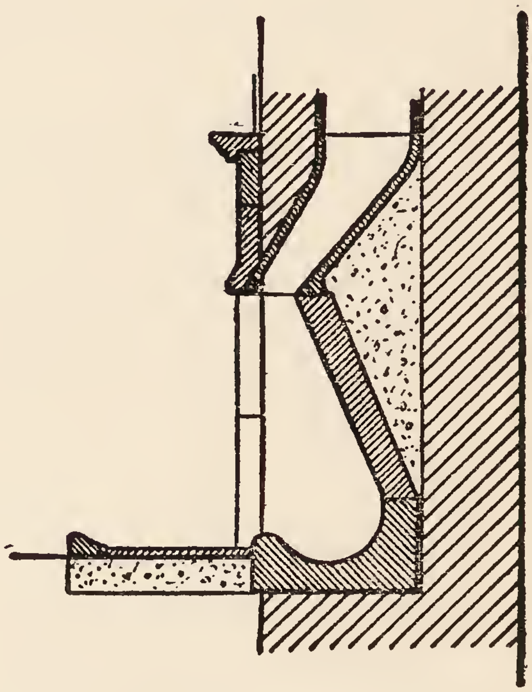


Fig. 23.

lighter, it immediately ascends, its place being filled by colder air from other parts of the room, which follows the same course. By this process the air of all parts of the room is gradually warmed.

The *disadvantages* of stoves as a means of warming rooms are :—

1. The ventilation of the room is not so perfect as in the case of open fire-places with large flues.

2. The air itself being raised in temperature by passing over the stove is thus rendered too dry. The actual amount of moisture present is unchanged, but the relative humidity, which from a health point of view is important, is greatly diminished,

because warm air is capable of holding more moisture before the saturation point is reached than cold. To obviate this it is a common practice to place a tin vessel containing water on the top of the stove.

3. The external surface of the stove may be so hot as to scorch the floating organic particles in the air and thus cause a disagreeable odour.

4. Carbonic oxide (carbon monoxide), an extremely noxious product of combustion, may pass into the room through imperfect joints or fissures, or, it is believed, through the pores of the metal in the case of cast-iron stoves when superheated. The headaches and feeling of discomfort, so often experienced by the occupants of rooms heated in this manner, are sometimes attributed to the presence of this gas. The production of this gas, which undoubtedly is found in stove-heated rooms, is attributed by some to the imperfect combustion of particles of carbon in the air, the result of coming in contact with the superheated surface of a stove.

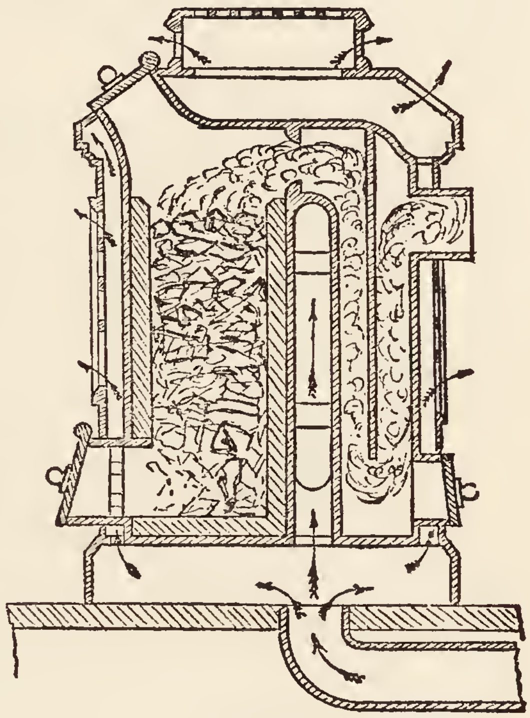


Fig. 24.

The first fault, namely, that of imperfect ventilation, may, to a large extent, be rectified by a special arrangement, by which fresh air is introduced by a pipe opening underneath the stove, and is discharged into the room after being warmed by passing through chambers in the interior of the stove. The accompanying sketch (Fig. 24) represents, in section, one of Musgrave's stoves, which are constructed on this principle. Many stoves of this description are now made.

To diminish the risk of superheating, every portion of the stove ought to be lined with fire-clay, which ought periodically to be inspected, and replaced when worn out. Such a precaution will prove economical in the long run.

By increasing the heated surface, and thus exposing a larger area to the cooling process of contact with the air of the room, the risk of superheating is also reduced, as iron is an excellent conductor of heat. This may be accomplished by the addition of vertical metal flanges projecting from the top and sides of the stove.

Gas fires are now very much used for warming rooms, particularly bedrooms. Cleanliness and economy in servants' time are the chief arguments in their favour. In all cases they should be provided with means of ventilation, by a pipe carried into a flue or to the outside. The ordinary fire-place may be adapted for warming by gas by filling the grate with asbestos blocks which are heated by means of a Bunsen burner. In this case there is no necessity for any special flue, as the ordinary chimney answers the purpose, and the ventilation is as perfect as with an ordinary fire. With this particular arrangement the loss of heat is very great, and to remedy this, gas stoves are now frequently fixed in front of the fire-place, with a short pipe leading into the flue to carry off the offensive fumes. It is essential for ventilating purposes that the opening of the fire-place proper should be quite free, and not filled up with sheet iron as is so often done, otherwise the ventilating effect of the chimney will be greatly lessened, particularly when the fire is not actually burning. The air in bedrooms in which gas stoves have been fixed in the objectionable manner just described, is very foul in the morning if the stove has not been burning all night, and in the absence of any special outlet ventilator.

Ventilating gas stoves are a great improvement upon the ordinary kind, from an economical as well as from a health point of view. They are constructed much on the same principle as ordinary ventilating stoves, fresh air being discharged into the room after it has been warmed by passing through a tube which is enclosed in a chamber in which the gas burns; this outer chamber is connected with the chimney by a pipe which carries off the foul products of combustion.*

Hot-water and steam pipes are frequently employed for warming the halls and passages of houses, as well as offices and public buildings. This system, if properly applied, is an excellent one, but one usually finds, in cases in which it is in operation, that all principles of ventilation have been completely disregarded. One has only to enter an office, for example, in which a number of clerks are engaged, and in which the ordinary open fire-places have been abolished in favour of hot-water pipes simply run round the walls, to realise the effect that such an arrangement has on the atmosphere of the room. The wholesome influence of the ordinary fire-place in changing the air of the room is lost, with the result that the same foul air, which has been breathed for hours on end, is circulating in warm currents round the room in question.

* Gas-heated radiators, see p. 76.

No system of warming by hot-water or steam pipes is admissible, unless both inlets and outlets are provided for ventilation. The best method of introducing air into a room warmed in this manner, is by so arranging the openings that the incoming air must first circulate over the hot pipes. By this means its temperature is raised, and thus, as already explained (p. 44), a more frequent change of the air of the room may be effected without causing a sensation of draught. This is now accomplished by *radiators* (Fig. 25), which have taken the place of the 4-inch pipes and coils formerly used. These radiators are constructed so that as large a surface as possible is exposed for radiation, and the circulation from the boiler is conducted by distributing pipes varying in size, in accordance with the distance they have to travel and the work they have to do, from $\frac{3}{4}$ inch to 2 inches.

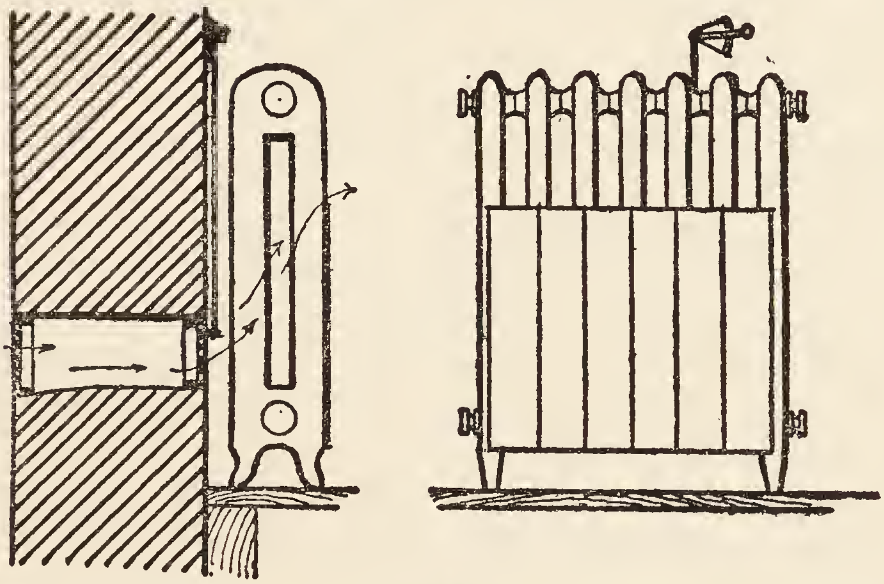


Fig. 25.

The smaller-sized pipes, however, owing to the friction which has to be overcome, are not very satisfactory, and it is found in practice that it is unwise to use pipes of a smaller diameter than 1 inch.

There are many types of radiators, and in making a selection it is important to avoid any, the design of which encourages the collection of dust. The columns should be free from decoration, have wide interspaces, and every part should be accessible to admit of dusting. The radiator shown in section and elevation in the drawing (Fig. 25) is a good one, and the plan shown of introducing fresh air into the room after it has passed over the radiator is simple and efficient. An opening is made in the wall behind the radiator, which is controlled by a valve, the air being compelled to pass over the radiator by fixing a baffle-plate in front,

which is detachable for cleansing purposes. Such an arrangement is to be preferred to the more elaborate ventilating radiators, parts of which are not easily accessible.

The ventilating radiator is much to be preferred to the non-ventilating one, but it must be remembered that in this case, as in all cases, ventilation cannot be combined with warming without adding to the first cost and the working expenses, for a larger boiler and larger radiators are required, and the consumption of fuel is in consequence increased. In the low-pressure system of warming just described the temperature of the pipes does not, as a rule, exceed 200° F., and a pipe is conducted from the highest point in the circuit to the outside for the escape of air or steam.

In another system (Perkins) no escape pipe is provided, and the pipes, which have an internal diameter of $\frac{7}{8}$ inch, are not connected with a boiler, but are simply coiled within the furnace. Under these circumstances the water circulates under pressure, and, therefore, the temperature of the pipes may reach to from 300° to 350° F.

About 8 feet of such piping will correspond, as regards heating power, to 12 feet of the old 4-inch piping. This system is not to be recommended for the purpose of warming houses, owing to the liability to overheating of the air, and also because of the sudden variation in temperature that is likely to result unless the fire is constantly kept up.

Gas-heated radiators are now frequently used for small installations, and, undoubtedly, by such an arrangement the available heat from a given consumption of gas is utilised to the best advantage. Most gas-heated radiators, however, are objectionable, because usually they are not provided with flues for carrying away the offensive products of combustion of the gas—a provision which in all cases should be insisted upon. This method of heating is well adapted for garages, where it is dangerous to employ open fires or stoves, and where a general hot-water circuit is not available. In such a case the gas-heated boiler is fixed outside, the flow and return pipes being carried through the wall to the radiator in the garage.

Steam, as a rule, in this country is only used for heating purposes in the case of factories, where it is necessarily on the spot as a motive power. In America it is largely employed for heating dwelling-houses. A very elaborate system of heating by steam is in operation in the Houses of Parliament. On the whole, perhaps the best system of warming houses is by the low-

pressure circulation and ventilating radiators, combined with open fireplaces. The English people have a strong prejudice in favour of the open fireplace, and it must be admitted that its cheerful appearance is worth a good deal, at the same time, it is wasteful, especially as usually constructed, and economy as well as efficiency would be effected by the combined system of open fires and low-pressure hot water ventilating circulation.

Steam, if available, may be used, indirectly, as a heating medium for a low-pressure hot-water circuit. In this case a steam pipe is carried to a water cylinder, within which it is coiled in order to increase the heating surface in contact with the water which circulates in the usual way throughout the building. It thus takes the place of the ordinary furnace and by regulating the steam pressure the heat imparted to the water, which is the distributing medium, may be readily adjusted to any desired temperature.

It is well to be cautious in deciding as to who shall carry out whatever system of warming by hot water or steam may be determined upon, as the successful working of all is dependent upon so many conditions, the non-compliance with one of which may result in failure. It does not follow that all who are willing to undertake the work are capable of satisfactorily completing it, and in this, as in all cases, experienced workmen are worth paying for.

Electricity as a means of heating is becoming more general, owing to the great reduction in cost of current in recent years. It has an advantage over gas in the fact that no offensive fumes are produced ; on the other hand, the consequent absence of the need for a flue prevents it from operating as an aid to ventilation. In the case of rooms which are only in use intermittently and for short periods, electric heating may prove to be convenient and even economical, but special provision must be made for ventilation in substitution for the fire flue.

In concluding this chapter, it may be well to emphasise the importance of the open fire-place in all ordinary rooms as a means of ventilation and a pleasant means of heating. It is desirable that the fire-place should be on the opposite wall to the window, and that the latter should be provided with a hopper ventilator, so that cross-ventilation may take place without causing draught.

CHAPTER IV.

SEWERAGE AND DRAINAGE.

An intelligent appreciation of the subjects dealt with in this and the following three chapters is perhaps the most essential element in the education of a sanitary inspector. Hardly a day can pass without his knowledge of the subjects being put to the test, and upon its thoroughness, the health and, it may be, the lives of many are dependent. The ignorance that still prevails, even among the educated public, regarding the most elementary facts connected with the drainage of houses, is indeed surprising. To them the whole question appears mysterious and complicated, but in reality it is not so.

Without going minutely into the **composition of sewage,** it may be said to consist of water containing certain refuse substances in solution and in suspension. These consist of urine and fæces of men and animals; house waste-water, containing grease, soap, and foul matters from the surface of the body and from clothes and general house washing. Sewage may also contain special pollution from manufacturing processes.

Human fæcal matter is sometimes excluded from the drains, and when it is so, it is popularly supposed that the sewage is comparatively innocuous, but this is certainly not the case. An estimate of the difference between the sewage of *water-closet* towns and of towns where the fæcal refuse is dealt with by the *midden or pail systems,* may be arrived at by comparing the value as manure of the sewage in each case.

According to the first report of the earlier Rivers' Pollution Commissioners, the value, for agricultural purposes, of 12 tons of sewage from towns without water-closets is equal to 10 tons of sewage from towns with water-closets. This fact is important as showing how essential it is to provide some means for treating all sewage, irrespective of its nature, before allowing it to enter a stream.

Ordinary sewage, when fresh, is comparatively inoffensive; but as all dead organic matter must necessarily undergo change (in the process of which it is split up into its simpler elements), and as during this process of *decomposition* (unless it takes place

under favourable conditions) nuisance is likely to arise, it is essential that precautions should be taken to prevent this. By reason of the artificial conditions of our existence, then, art must assist in these natural processes; but we may rest assured of this, that if man does his part of the work, Nature will do hers.

Putrefaction is the result of an attack upon dead organic matter by *minute living germs* or *bacteria*, ever present in sewage and air; the process is similar to, in fact it is, *fermentation.* Under favourable conditions, these germs multiply with enormous rapidity, until in time complete dissolution of the material is accomplished, and during this time a continual discharge of fœtid organic matter and foul gases takes place, which contaminate the atmosphere, and tax to a great extent the purifying effect of the oxygen it contains. This alone must seriously affect the health of the inhabitants, and if it is not in itself directly responsible for the production of disease, there is no question but that it greatly favours the extension of diseases of the infectious class. Under these circumstances, it is of the utmost importance that all sewage and refuse should be disposed of in a manner that will least contribute to the injurious consequences just described. The great principle then to keep in view is the *immediate and thorough removal of all fluid refuse,* and the important points to determine, in judging of the efficiency of any system of sewage removal, are as to whether it is *immediate* and *complete.*

Methods of Sewage Removal.

Having considered the broad principles with which all perfect methods of sewage removal must comply, we must now go a little farther and apply these principles to the different methods now recommended.

The present systems of sewage removal may be considered under two heads—viz., the **water-carriage system** and the **conservancy system.** In the former, solid fæcal matter is introduced into the sewers, while in the latter it is excluded.

Great difference of opinion has hitherto prevailed as to which ought to have the preference, but the water-carriage system is now universally admitted to be the better one, except, perhaps, in the case of scattered populations dependent for their water-supply upon local wells. The arguments in favour of the water-carriage system seem unanswerable.

If it were possible to get rid of the ordinary slop water by

some other means than sewers, then it might become a matter for consideration whether the necessity for the removal of excreta alone would warrant their introduction, but as sewers must exist for ordinary waste-water purposes, the only point to determine is whether the addition of excreta is expedient or not. Now, so far as the composition of the sewage of water-closet towns is concerned, as compared with that of towns in which the dry method is in operation, the difference, as already pointed out, is very little, but the volume in the one case as compared with the other is considerably greater. Six gallons per head per day increase of volume in the case of water-closet towns (*Parkes*) makes a considerable difference in the sum total of sewage that has to be disposed of; and in the case of inland towns, particularly where the absence of sufficient fall necessitates the pumping of every gallon, for the purpose of land or other treatment, before it is discharged into a stream, such an addition may become a matter for serious consideration. Then, again, it may be that the water-supply is limited, and cannot be supplemented without considerable expenditure, in which case the saving of 6 gallons per head per day must not be overlooked.*

To obviate these objections, various plans for utilising the ordinary house water-waste as a flush for water-closets have been devised, and some town authorities have endeavoured to overcome the difficulty in this way by methods which will be described in the next chapter.

Many Medical Officers of Health have had reason to deplore the introduction of such methods, and, plausible though the arguments brought forward by their advocates in the first instance were, the objections to the system which practical experience has brought to light demonstrates how unwise it is to disregard essential principles and relax, however slightly, the rule of *immediate* and *thorough* removal.

There can be but little question that the water-carriage system is the cleanest, most rapid, most convenient, and cheapest method of sewage removal.

The dry system, or the **conservancy system** as it is termed, has been adopted in some towns, but, even where carried out on the most approved principles, it must necessarily give rise to nuisances in densely populated areas. On the ground of expense, also, it is found to be a mistake, and were it not on account of the outlay that has been incurred, it is probable that most authorities who have adopted the system would abandon

* The estimate of 6 gallons is, probably, in excess of the actual figure.

it. It is only in scattered rural districts where there is land enough attached to each house, on which the excrement can be disposed of, that the system is at all admissible; the difficulty in dealing with the excreta in populous districts necessitates an annual expenditure which is not by any means recouped by the sale of the manure. The mistaken idea that the introduction of ordinary water-closets into districts greatly increases the difficulty of treatment, is probably answerable in most cases for the adoption of the conservancy method of sewage removal, and the sooner the true state of the case is understood by authorities the better.

Privy-middens (for definition, see *Appendix*) ought undoubtedly to be abolished, particularly in populous districts, and, if excrement is permitted to remain on the premises, it must be under conditions least harmful to health. The **earth-closet,** if the necessary labour can be provided, is perhaps the best dry system of removal, but the trouble entailed in attending to essential details is too great to admit of its adoption, except in better-class houses and schools. The **pail system,** with frequent and regular removal, is less objectionable than the privy system, but it would be well if authorities of populous districts would come to the determination to abolish conservancy methods.

This question is really of vital importance from a health point of view, as is amply demonstrated in the reports of Medical Officers of Health. Apart from the general health of a town's inhabitants, it has been shown conclusively that the incidence of enteric fever and epidemic diarrhœa is greater when conservancy methods are in operation. Perhaps the strongest proof of this will be found in the reports of Dr. Boobbyer, the Medical Officer of Health of Nottingham, who has made this question the subject of special study. As a contrast to Nottingham, where the pail system is very general, may be mentioned the highly satisfactory decline in the enteric fever death-rate of Leicester coincident with the systematic abolition of the pail system in that town and the substitution of water carriage.

The term **separate system** is applied to a water-carriage system in which separate channels are provided for the rainfall. The addition of surface water to the sewage of inland towns greatly taxes the efficiency of all methods of sewage treatment, and, although useful as a flush for sewers, it is too irregular and uncertain to be admissible where flushing is specially necessary.

Towns without a proper system of sewers are to be congratulated as regards this point, for they are in a position of being able

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to make use of what sewers exist as storm-water carriers, and to start *de novo* to construct sewers on the separate system.

Sewers as a Danger to Health.

One often hears it stated that certain towns were perfectly healthy, and experienced no nuisance from the disposal of their sewage, until the introduction of a general system of sewers. Such a statement must be received with a considerable amount of qualification, although it contains an element of truth. Many examples of the old order of things are to be found even now in small towns, where the fluid refuse is simply discharged from the houses on to open channels communicating with street gutters along which it travels to the nearest ditch or stream; although sometimes it is conveyed there in brick sewers with which the street gutters are connected, the whole being periodically flushed with storm water. Now, no doubt, such a system is extremely unsightly, and the risk of well-pollution and other dangers, from the saturation of the soil with sewage which percolates freely from numerous stagnant pools along the course of the rude channels, is great; but that there is perfect "disconnection" and free "ventilation" there is no question, and, when compared with an arrangement which connects each house direct with an unventilated and possibly badly-constructed sewer, it is certainly to be preferred, especially if the people are not dependent upon local wells for their water-supply. This, however, is no longer a true comparison; we now appreciate the importance of flushing, trapping, disconnecting, and ventilating our drains and sewers. The only instances (three out of twenty-four), in Dr. Buchanan's enquiry (p. 4), in which the deaths from enteric (typhoid) fever had increased since the introduction of sewers, etc., occurred in towns where, undoubtedly, the sewage arrangements were imperfectly carried out. In the case of the other twenty-one towns, an average reduction of 45·4 per cent. took place.

Construction of Drains and Sewers.

Drains and sewers must be so constructed as to comply, in every respect, with the principle of immediate and perfect sewage removal. There is considerable confusion with regard to what is a drain and what a sewer. Shortly, the definition, as laid down by the Public Health Act, is that a "drain" is a channel which receives the drainage of one building or set of premises

within the same curtilage, and a "sewer," that which receives the drainage of two or more buildings or premises (see Appendix).

Drains and sewers should be water-tight, smooth in the interior, and small enough to be self-cleansing; they should, if possible, follow a straight course and have a sufficient fall, varying in accordance with the diameter, and, as far as possible, of the same uniform rate; where curves are unavoidable, they should not be abrupt, or better still, at such points, where tributaries join, manholes should be provided. Ample provision should exist for ventilation, so that offensive gases may not stagnate but have free outlet into the open air.

The question whether a trap should be interposed between the drain and the sewer is one which has been the subject of much controversy in recent years. Lately this formed the subject of an inquiry by a Departmental Committee, whose report, published in 1912, deals exhaustively with the evidence submitted, and with certain carefully conducted experiments bearing upon the question. The conclusions arrived at are somewhat lengthy, as there are so many qualifying circumstances, but the following is a short summary of the more important ones :—

1. From a health point of view drain air is more dangerous than sewer gas, because, owing to the splashing of the sewage, the air in the former is impregnated with sewage bacteria from which sewer air is practically free.

2. The introduction of a trap, while effectually cutting off sewer air from house drains, tends to obstruct the flow of sewage, and frequently leads to stoppage. The injury from such stoppage, however, may be minimised by constructing at least the lower part of the drain of iron pipes, and by closing, with a removable cover, the usual open channels in the interception chamber, thus causing the block to become evident as soon as possible.

3. With proper ventilation of house drains by means of soil-pipe ventilators and anti-syphonage pipes, there is no need for providing the usual fresh-air inlet, and thus one of the objections to the intercepting trap may be obviated.

4. Apart from bacteriological evidence, both experience and experiment show that sewer air is not seriously harmful, but it is offensive, and for that reason it may, in varying degree, according to the acuteness of the sense of smell, by its unpleasantness, injuriously affect the comfort and physical well-being if not the health of individuals.

5. If then the drains are freely ventilated and the tops of the ventilators are situated a considerable distance from windows,

there does not seem to be any need for insistence on the provision of an intercepting trap. Moreover, in any case, whether such a trap is provided or not, this requirement is essential, having regard to the greater potential injury attributable to drain air.

It would seem, therefore, that given perfectly trapped and freely ventilated drains, the balance of evidence is in favour of the omission of the intercepting trap.

Drains are very often needlessly large, and thus the flush is very much reduced. For example, given two drains of equal fall, carrying the same volume of sewage, the one 4 inches in diameter and the other 6, the rate of travel, and, therefore, the flushing power in the former case will be greater than in the latter, because the depth of fluid in the smaller pipe is greater than in the larger. The accompanying sketch (Fig. 26) shows the comparative difference in depth of the same volume of fluid in a 4-, 6-, or 9-inch pipe. As a rule, the diameter of house drains need not exceed 4 inches, except in the case of very large establishments. Too often, even now, a 6-inch pipe is used when a 4-inch would answer all requirements, and, in the case of old houses, one frequently finds that even the tributary drains are constructed of 9-inch pipes.

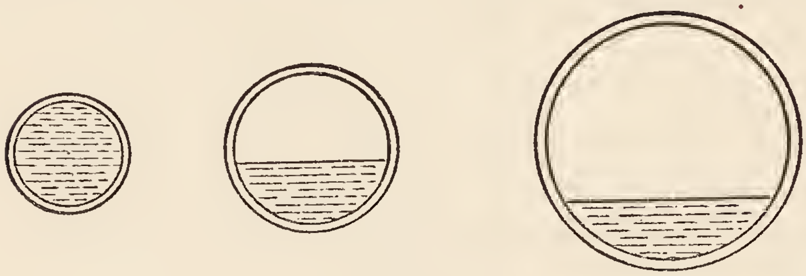


Fig. 26.

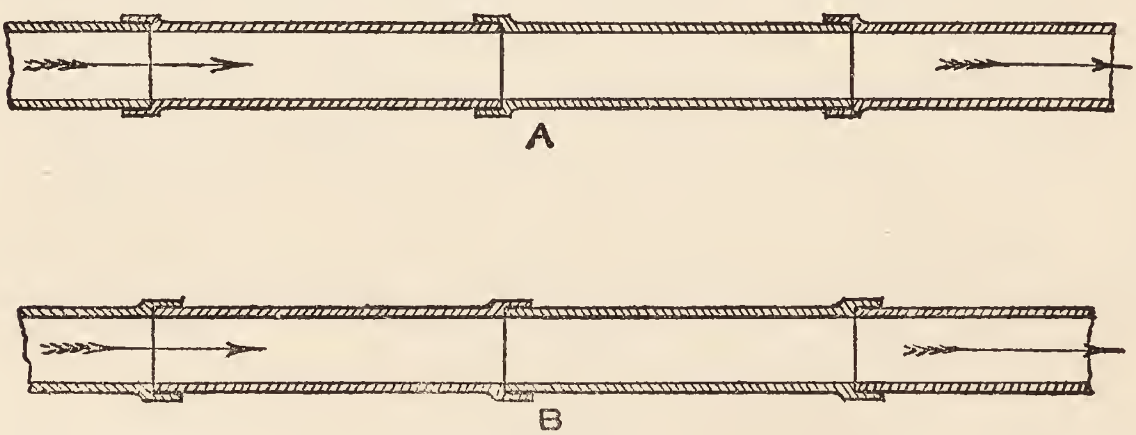


Fig. 27.

Even in these days, when all who are concerned in building operations might be expected to be familiar with such elementary details, it is remarkable how common it is to provide needlessly large drains, under the mistaken belief that the larger the drain, irrespective of what it has to carry, the less likelihood of stoppage

from deposit. It never seems to occur to them to consider the maximum flow such drains have to provide for, and to apply the simple formula for determining their needful diameter.

Whether drains are intended to convey the ordinary waste-water only, or in addition the excreta and urine of a household, they must be constructed with equal care and attention to detail.

Socketed glazed stoneware or **iron pipes** are alone admissible. They should be laid as far as possible, in straight lines, with the socket end directed towards the sewage flow, as represented in Fig. 27 (A), not as shown in (B); the fall ought to be uniform, and not less than 1 foot in from 40 to 60. If such a fall cannot be obtained, then some artificial means of flushing, which in all cases is desirable, becomes essential, in order to ensure perfect cleansing of the channel.

Before proceeding to lay the pipes, each one should be carefully examined, and any that are imperfect should be rejected. In outline they should be perfectly round, otherwise the spigot will not fit accurately into the socket; the internal surface must be smooth and thoroughly well covered with glaze; and they must be entirely free from cracks or flaws of any description, otherwise the drain will not be water-tight.

The trench in which the pipes are laid should be dug, not piece by piece, but in lengths, and it is important not to interfere with the solidity of the floor by excavating, in the first instance, to a greater depth than is necessary, as this necessitates the replacement of soil and thus causes a risk of after subsidence. If it should happen, in the process of digging, that more soil has been removed than is necessary, in replacing it, so as to equalise the gradient, the replaced soil must be firmly beaten down, otherwise subsidence will afterwards occur which will interfere with the proper flow of sewage, and, possibly, impair the integrity of the joints and cause leakage.

Unless the ground is naturally solid, all stoneware drains should be laid on a bed of **concrete** 4 inches in depth, and, if it should be found necessary to carry such a drain under a house, it should be entirely imbedded in concrete of at least the same thickness. The latter precaution ought to be observed in all cases where it is necessary that a drain should be laid in close proximity to a well, although, if circumstances permit, it is better to select another route for the drain or use iron pipes.

In laying the pipes, a point of the utmost importance to remember is, that they should rest on their bodies on the bottom of the trench, and not on their sockets, a portion of soil being

removed at points corresponding with each socket to allow of this. It is the usual practice of inexperienced drain layers to disregard this precaution, with the result that, when the trench is covered in, in place of the weight of the soil being uniformly distributed along the entire length of the pipe, the pressure is concentrated upon each joint, and, in all probability, causes the recently introduced cement to be expelled from the sockets.

Joints must be made with extreme care, the best Portland cement being alone admissible for stoneware drains. Even now it is not an uncommon practice to use *clay* for the purpose. An ignorant workman may, possibly, be excused for following past custom in this respect, but builders and architects are greatly to blame if they countenance such a proceeding.

Having carefully cemented the joint, not only at the top, but all round, the workman, before making the next joint should

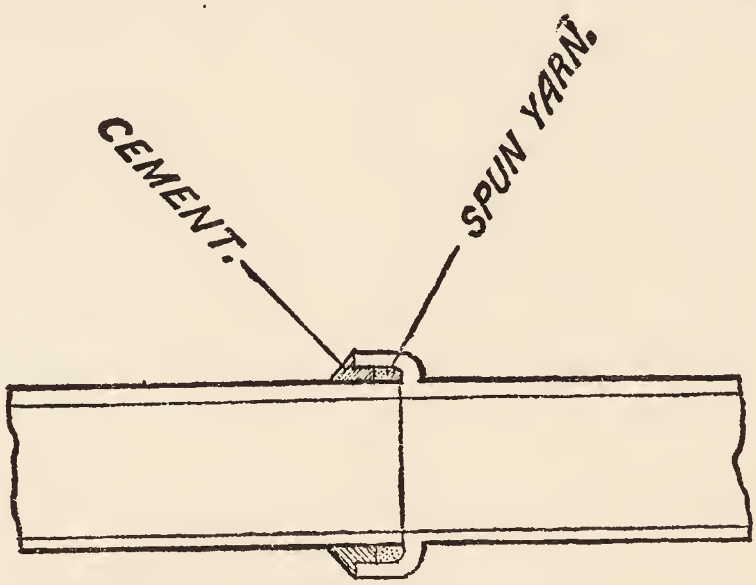


Fig. 28.

satisfy himself, by raking the pipe out with a specially constructed wooden implement, that none of the cement has been pushed into the interior, otherwise it will interrupt the proper flow of the sewage and lead to obstruction.

Before replacing the soil the drain ought to be inspected by a responsible person, who should test the integrity of the joints by means of the hydraulic test to be afterwards described. The first portion of soil must be replaced with care, and should be packed well under and on either side of the pipes, so as to guard against after-displacement, which is likely to cause fracture of the joints.

Fig. 28 illustrates a good method of making a stoneware drain joint. Teased-out hemp-spun yarn, free from tar, is first steeped

in fluid cement (cement grout), and then well rammed into the joint, so as to fill it about half. The joint is then completed with stiff cement.

Various **patent joints** have been invented from time to time, and it is found expedient to make use of them in certain cases, as for example when pipes have to be laid in water-logged soil, and difficulty is thus experienced in making a water-tight joint in the ordinary manner. One of these (Stanford's), which was among the first to be introduced, is made by Doulton & Co., Lambeth. A rim of smooth and durable material is cast on to the spigot end of the pipe, and to the interior of the socket, so as to insure a tight fit, and a space is left to allow of cement being introduced as an additional precaution. More recently this joint has been further improved, the composition which is cast on the spigot of the pipe being made convex on the surface, as shown in the sketch (Fig. 29). The advantage claimed for this arrangement, although it is a doubtful one, is, that if from any cause after-subsidence should occur, a certain amount of displacement of the pipes may take place (on the same principle as a ball-and-socket joint) without the integrity of the joint being impaired.

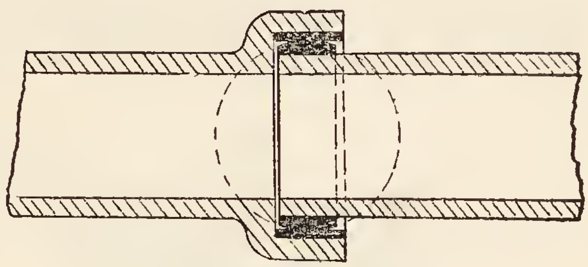


Fig. 29.

The process of laying these pipes is very simple. Having carefully wiped the spigot and socket, a small quantity of specially-prepared lubricant is applied inside the socket of the one pipe, and round the spigot of the other; they are then pressed home, and the joint is complete. These pipes are made in various sizes from 4 to 18 inches.

As regards the question of the durability of these joints, time alone can decide, but it is claimed for the composition that it has shown no evidences of deterioration in pipes that have been taken up after having been in use for fifteen years.

Another joint, the **Archer patent,** is constructed so as to allow of the joint being made by liquid cement being poured in at an opening at the top of the socket, after the pipes have been adjusted, a luting of clay being first introduced, to act simply as a barrier to the entrance of the cement into the interior of the pipe.

A somewhat similar, although a better joint, **Hassall's patent (Fig. 30)**, is now frequently used in cases in which difficulty

is experienced in laying ordinary pipes. Two bands of bituminous material are cast on to the outside of the spigot, and two similar bands are cast on the inside of the socket, so that when the pipes are laid together the interspaces form an annular groove which terminates in two openings at the top. The spigots and sockets are lubricated with a special plastic cement before being adjusted, the fluid Portland cement is run in at one of the top openings until it makes its appearance at the other, and thus the joint is encircled with a band of cement which forms a very solid and durable union. Although these pipes are more expensive than ordinary drain pipes, in cases in which their use is indicated they may, in the end, prove more economical, owing to the comparative ease with which they can be laid under adverse conditions. Also, the advantage of having sewers and drains with tight joints is worth paying for, especially in cases where the sewage has to be pumped to the disposal works, when the question

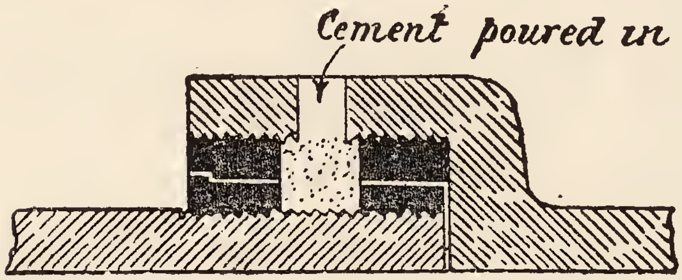


Fig. 30.

Fig. 31.

of limiting the volume by excluding infiltration water becomes all important.

Patent joints, however, have not by any means come into general use. From a sanitary inspector's point of view, therefore, it is important that the points to be attended to in the making of an ordinary cement joint should be thoroughly appreciated. Iron pipes necessitate a caulked lead joint (see p. 127).

Junctions must always be in the form of a **V**; no tributary drain should join at right angles. The figure (Fig. 31) represents a **V**-shaped junction pipe. Such pipes are made in all sizes. It is important to remember, that unless tributary drains join main drains obliquely in this manner, so that the sewage enters in the direction of the flow, splashing will occur, and this, in time, is likely to lead to obstruction, owing to a deposit being gradually formed from the drying of the sewage that has been driven against the sides of the pipe, above the water-line. It is needless to remark that it is a wrong proceeding to connect a tributary

drain by knocking a hole in the main drain, although the practice is by no means an uncommon one.

Bends in drains should, as far as possible, be avoided; when they are unavoidable, the curve ought to be an easy one. Pipes with easy bends are made, and should always be used when bends are necessary (Fig. 32, B), although it is a common practice to use straight pipes for the purpose. The effect of such a proceeding is shown by the accompanying sketch (Fig. 32, A). Not only are objectionable angles formed at the junctions of the pipes, which tend to interfere with the easy flow of sewage; but what is still more important, the impossibility of accurately adjusting the spigot end of one pipe into the socket of the next, in the case of straight pipes laid otherwise than in a straight line, necessitates an imperfect joint being made.

In connecting a branch drain with a main drain easy bends should be used (Fig. 33), but, when it is necessary to depart

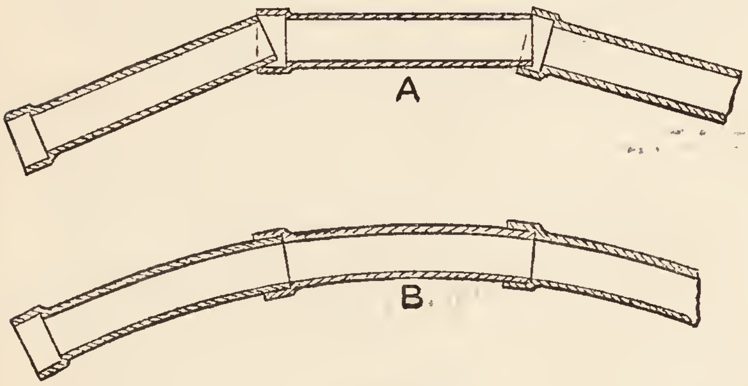


Fig. 32.

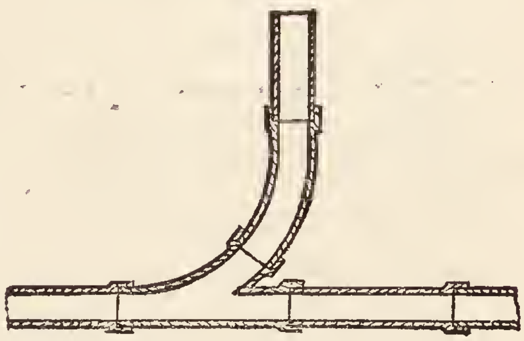


Fig. 33.

from the straight line in the case of the drain itself, or in the case of sewers, by far the best proceeding is to construct a **manhole** at the point where the curve occurs, in a manner to be presently described. Indeed, whenever practicable, all tributary drains and sewers should join the main drain or sewer, as the case may be, at a manhole, so as to facilitate inspection and cleansing.

Inspection pipes of various kinds are made, and ought to be introduced at the top end of all branch drains, particularly when they are laid in concrete. The necessity for breaking into a drain, should it become obstructed, is thus avoided, as the clearing rod may be introduced at the opening provided.

Perhaps the simplest method, and one which does not entail any disturbance of the surface, is to introduce what would correspond to a V-shaped straight junction with the opening directed upwards (Fig. 34), to which a pipe, leading from the surface of

the ground is connected, and along which a rod may be passed. The top end of this pipe must be sealed, either by a special cap or by a piece of slate fastened with clay, a small movable stone slab with ring attached being placed so as to mark the situation and allow of easy access to the opening.

Another method of inspection (Fig. 35), is by means of a pipe divided longitudinally into two segments, the upper of which may be removed by means of a chisel.

A still more convenient arrangement than any of these is now available in the shape of various kinds of *access* gully-traps. These can be obtained from most makers and may be used with advantage in all new drainage-work.

Sewers are constructed of pipes or of bricks according to their size. In the former case the same rules have to be observed as have been described in the case of drains.

The proper *size* and *fall* for a sewer is a question for engineers, and both are dependent upon the amount of the sewage flow.

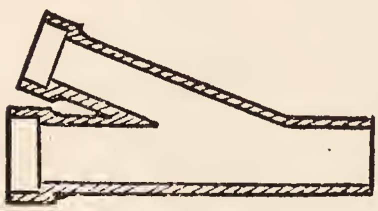


Fig. 34.

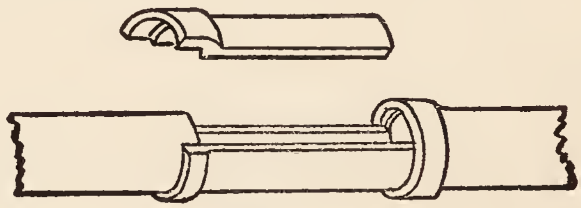


Fig. 35.

The following concise summary is given in *Hygiene* by Dr. Louis C. Parkes :—"To prevent deposit, sewers should be rendered self-cleansing by being constructed with a sufficient gradient, and of a size suitable to the volume of sewage which they will ordinarily be required to carry. According to Mr. Baldwin Latham, sewers of from 12 to 24 inches diameter should have a gradient sufficient to produce a velocity of not less than $2\frac{1}{2}$ feet per second, and in sewers of larger dimensions in no case should the velocity be less than 2 feet per second. For large sewers a less gradient is required than for small sewers to produce the same velocity ; but the volume of the sewage to be conveyed must be very much greater for the large than for the small sewer. A sewer 10 feet in diameter having a fall of 2 feet per mile ; a sewer of 5 feet in diameter having a fall of 4 feet per mile ; a sewer of 2 feet in diameter having a fall of 10 feet per mile ; and a sewer 1 foot in diameter with a fall of 20 feet per mile ; will all have the same velocity of flow, but the volume of sewage in the 10-foot sewer must be 100 times, in the 5-foot sewer 25 times,

and in the 2-foot sewer 4 times the volume of sewage in the 1-foot sewer." *

Circular stoneware pipes should be used for all sewers up to 18 inches in diameter, but sewers of larger capacity should be egg-shaped, with the small end of the egg downwards, and constructed of good impervious bricks laid in the best Portland cement (see p. 23). The advantage of an egg-shaped sewer is the resulting increase in the depth of flow and consequent diminution of friction.

Manholes ought to be introduced at intervals of not less than 100 yards, and the convenient sites for these are where tributary sewers join, but, as already stated, it is essential to construct one at each point where the sewer has to alter its straight course. The same holds good in the case of the drains of all well-drained establishments; the satisfaction of being able to look through, and to pass a rod through from one end to the other of the drains and their tributaries, amply repays the extra outlay.

A manhole chamber (Fig. 36) is built of brick-work set in cement, and the drain or sewer is continued along the floor of the chamber by means of open half-channel pipes set in a bed of concrete. The surface of the concrete should be raised some inches above the edges of the half-channel pipes to prevent the sewage from overflowing on to the floor of the chamber, and it should be *floated* with cement all over so as to present a smooth and impervious surface. At points along the main channel tributary drains are connected by means of *curved* half-channels similarly laid in concrete, the junctions being formed by special half-channel junctions being introduced in the course of the main channel at these points. All street manholes should be fitted with a perforated iron lid to allow of the free circulation of air in the sewers (see Fig. 36), a bucket or tray being suspended under the perforations to catch any dirt that may enter from the road. In the case of private drains, the manhole lids in the course of the drains should be air-tight.

Hitherto, in the case of drain connections with sewers, it has been the practice to fix at the terminal manhole a perforated cover for the admission of air, but, in view of the Departmental Report already referred to (p. 83), it is probable that this practice will be discontinued, because if the intercepting trap between the drain and sewer should be omitted a perforated cover would,

* For an excellent description of the method of calculating the flow of water through pipes see the volume on *Water Works*, Weale's Rudimentary Series.

of course, be inadmissible. In the case of drains discharging into cesspools an intercepting trap is essential.

So much for the points that have to be attended to in connection with the laying of drains and sewers. A description of the various forms of traps has purposely been omitted at this

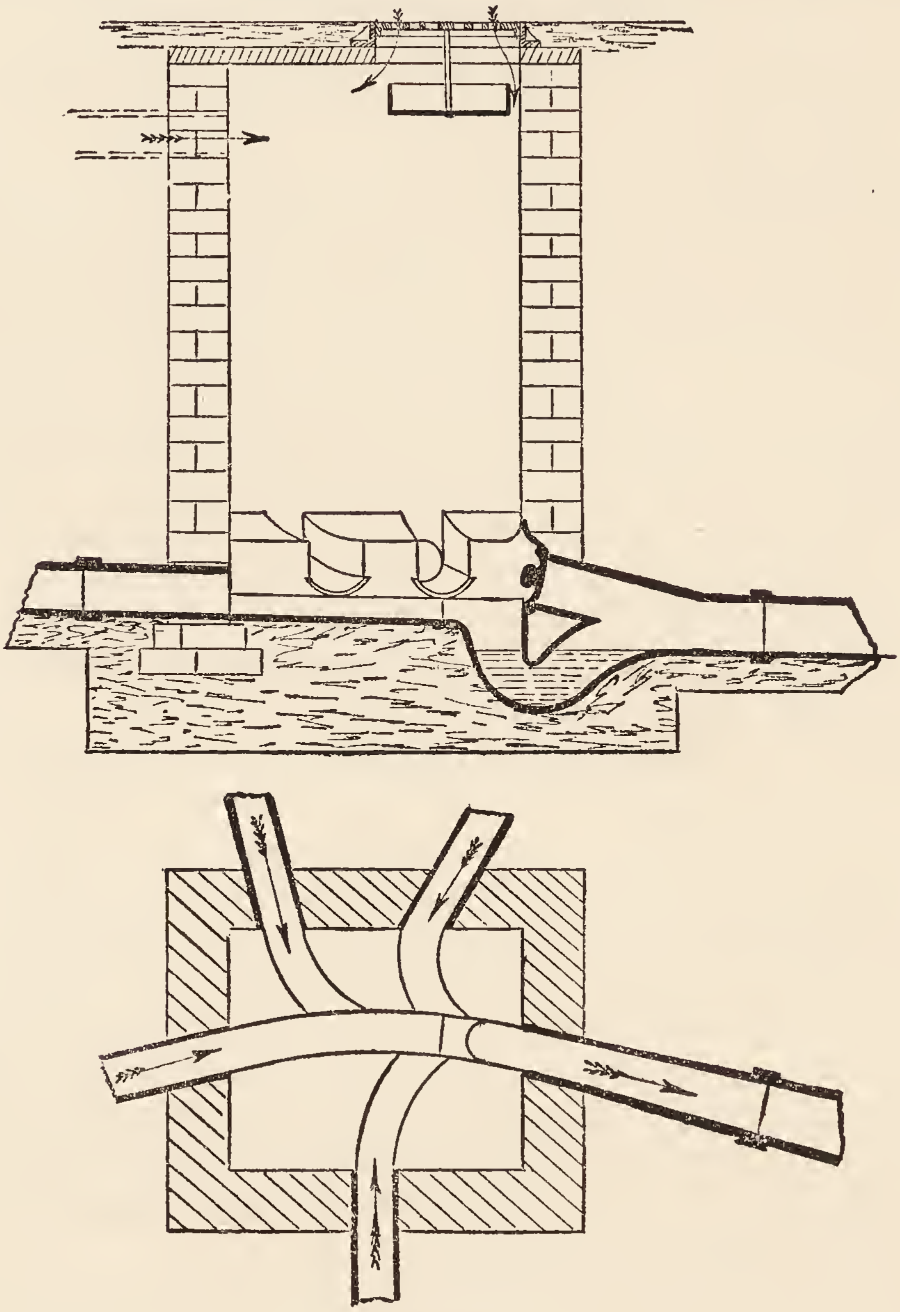


Fig. 36.

stage, as they may more fitly be described when sanitary appliances come to be considered.

As regards the supervision of the work of drain laying, it is impossible to exaggerate the importance of keeping a watchful eye upon the workmen to insure that every detail is attended to. Unless faults are discovered during the progress of the work,

they are exceedingly likely to be overlooked altogether, until, sooner or later, serious consequences result. The fact is, men are frequently employed as drain layers who are entirely ignorant of the principles to be observed and the risks to be guarded against, and until it becomes the custom to require such men to be registered, a requirement which is happily becoming general in the case of plumbers, we cannot look for much progress in this department of sanitary work.

CHAPTER V.

SANITARY AND INSANITARY WORK AND APPLIANCES.

THE various appliances connected with the drainage of houses and premises have now to be considered.

In forming an opinion regarding the efficiency of any appliance, experience is the only safe guide, but one thing is certain, that no mechanism is satisfactory which does not comply with the principles of cleanliness and simplicity. Many inventions, however ingenious at first sight they may appear, and however well they may answer experimentally, have to be discarded on account of unforseen circumstances which interfere with their efficient working in practice.

In conducting an examination into the sanitary condition of premises, a familiarity with the errors that are likely to be met with is hardly less important than a knowledge of what is right and proper, and it is essential that the enquiry should be conducted systematically, step by step; nothing being taken for granted, otherwise, sooner or later, a mistake will be made.

As **traps** are met with in connection with most appliances, it is convenient that they should first be discussed. The purposes served by traps, and the conditions with which all must comply, are subsequently detailed (see p. 102). The following are the common varieties met with in practice :—Syphon-trap, Gully-trap, D-trap, Bell-trap, Antill's trap, and Dipstone trap. The two first-mentioned traps (or a modification of them) are the only ones admissible; all the others are more or less objectionable.

The simplest form of **syphon-trap** for use in the course of a drain is an ordinary pipe with a bend in it (Fig. 37); both those represented in the drawing, however, are faulty for various reasons. The first because (1) the dip is not sufficient to provide a proper water-seal; (2) the bottom of the trap is rounded, consequently there is a risk of its being fixed out of the level; (3) there is no provision for the ventilation of the drain, in the shape of an inlet opening on the house-side of the water-seal; and (4) no means of access to admit of the trap or the drain beyond being cleared out, should either become obstructed, are provided.

The second is open to the same objections as far as the first and second points are concerned, and as regards the third, although means of access is provided, it is not at a point that will allow of ventilation, or the unstopping of the drain beyond. There is another objection to this, which is a form of trap sometimes met with, and that is that floating matters are likely to accumulate in the central shaft.

The trap which is best fitted for the purpose (Fig. 38), and which is not open to any of the foregoing objections, has two openings, in addition to the inlet and outlet, one at A in the sketch, which is carried up by means of pipes to the surface of the ground, where it is covered by an open grating and thus acts as an air inlet (a requirement which, according to the Departmental Report, is not deemed to be an essential, p. 83), and the other

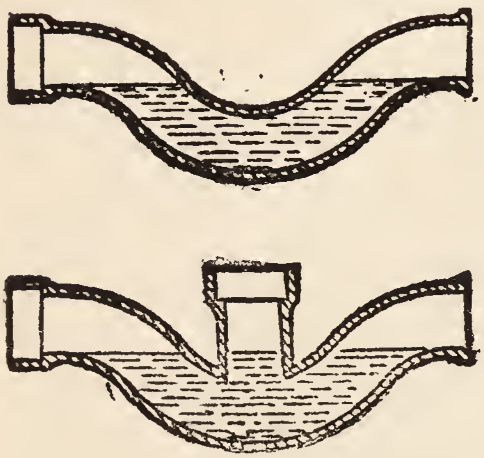


Fig. 37.

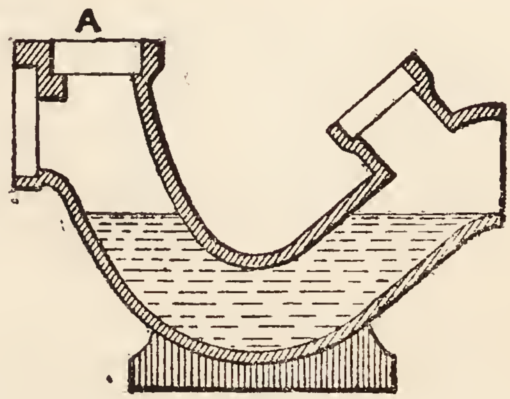


Fig. 38.

beyond the seal, which may be used for cleaning the drain between the trap and the sewer or cesspool. It will be noticed that this trap has a deeper seal than the others; that the drain inlet is well above the outlet, thus affording a better flush; and that it stands on a flat bottom, which facilitates its being laid level.

In the event of the drain terminating in a manhole, such as has been described on p. 91, previous to joining the sewer or cesspool, and it is the intention to disconnect the drain, a special form of disconnecting trap, represented in the sketch (Fig. 36), with a raking-arm or by-pass to allow of the drain being cleared beyond the trap, should be used. In this case an inlet for ventilation may be provided by means of openings in the manhole cover, or if, by reason of its position, there is an objection to this, by a special opening at the side, shown by dotted lines which is carried up some distance above the ground level, but, as already stated, such opening is not now considered to be an essential.

Fig. 39 represents an improved trap introduced by the late Professor Corfield; the syphon is egg-shaped in section and curtailed in calibre; also, the raking-arm has a second inlet which is sealed by a movable plug with chain attached. This trap is more likely to be self-cleansing, but should it become obstructed, as may sometimes happen, the sewage which in consequence would collect in the manhole would be liberated by pulling the chain; without this contrivance it would be necessary to empty the manhole by means of a pump or with buckets before any one could enter it to unstop the trap. This difficulty, however, can be overcome in another way—namely, by fixing removable

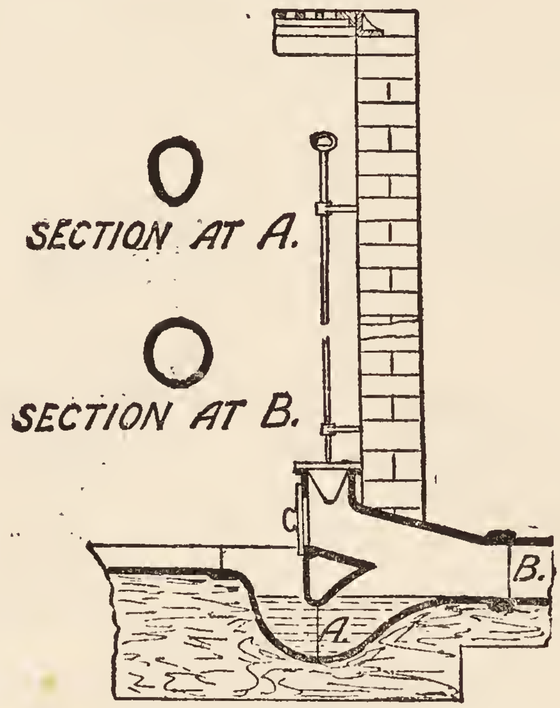


Fig. 39

covers to the open channels, as suggested by the Departmental Committee.

The question of the necessity for trapping a drain before it joins the sewer has already been discussed (p. 83).

In the case even of recently drained houses one not infrequently finds that a trap similar to that just described (Fig. 38) is placed at the point where the soil-pipe joins the drain, notwithstanding the fact that another and similar trap is placed at the terminal end of the drain. Under these circumstances, the soil-pipe cannot answer the purpose of a ventilator for the drain; consequently it is necessary to connect another ventilator with the drain beyond the needless soil-pipe trap, and carry it up parallel to the soil-pipe ventilator. It is undoubtedly best not

to place a trap at the bottom of the soil-pipe, for, not only does this do away with the necessity of going to the expense of providing a special drain ventilator in addition to the soil-pipe ventilator, but it entirely abolishes the risk of the occasional odour that may sometimes be detected coming from the air inlet at the foot of the soil-pipe, at the time when the contents of the closet are being discharged.

Gully-traps are used for the purpose of cutting off the various waste pipes of the house (bath-room, sink, etc.), and the rain-pipes from direct connection with the drain. They are also placed in yards, for the purpose of receiving the rainfall, and the water used for swilling purposes, carriage washing, etc. In fact, whenever it is necessary to make a connection with a drain, apart from the soil-pipe connection, some form of gully-trap must be employed.

In the case of yard gullies, evaporation during warm weather is apt to lower the water-seal, and so render the trap inefficient. For this reason it is essential, at such times, to periodically replenish the traps with water. An excellent gully, Crosta's patent, is now made by a firm in Nottingham; it is so designed that the least possible water surface is exposed, and so evaporation is reduced to a minimum.

Gully-traps must invariably be placed outside the house; under no circumstances whatever is it justifiable to fix one within the house—in the cellar, for example—although one frequently finds that this is done. Indeed it is by no means uncommon to find one of these, or even a bad form of trap, fixed in a back-kitchen, larder, or dairy, and connected with the drain simply as a convenience for floor washing.

A glance at the conditions upon which the efficiency of all traps is dependent (p. 102), will at once explain the reasons for this caution, but the most potent one applicable in this instance, is the risk of the trap becoming unsealed owing to evaporation. Especially is this the case as regards cellars, owing to the interval that is likely to elapse between each occasion of cleansing.

In the case of a laundry, where a considerable quantity of water must necessarily fall on the floor, the plan to adopt is to lay the floor with a slope towards a channel leading to an outside gully.

A gully-trap is an excellent thing in its proper place, but its place is not within a house.

The ordinary form of gully-trap (Fig. 40) is very simple and inexpensive, and it answers the purpose well, so far as the yard

drainage and rain-pipe discharge is concerned. It is essential that it should be periodically cleaned out, but this applies to all alike. The grating, which may be of iron or stoneware, although the former is preferable, is surrounded by a cup-shaped arrangement of stoneware.

Street gullies, which of course are large, are similarly constructed, with the exception that the iron gratings are fixed by means of brickwork set in cement. Gullies are made with side inlets below the gratings, for the connection of waste-pipes; this arrangement, although unobjectionable, is not quite in accordance with the model bye-laws, which require that waste-pipes shall discharge on to an open channel leading to the trap.

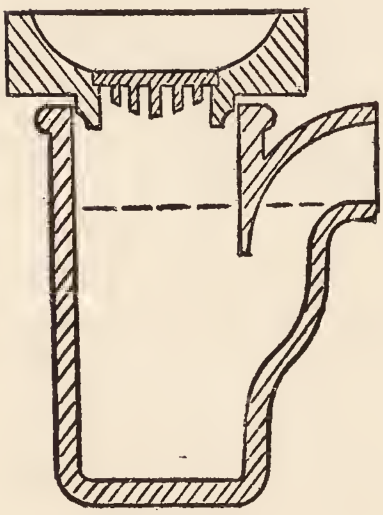


Fig. 40.

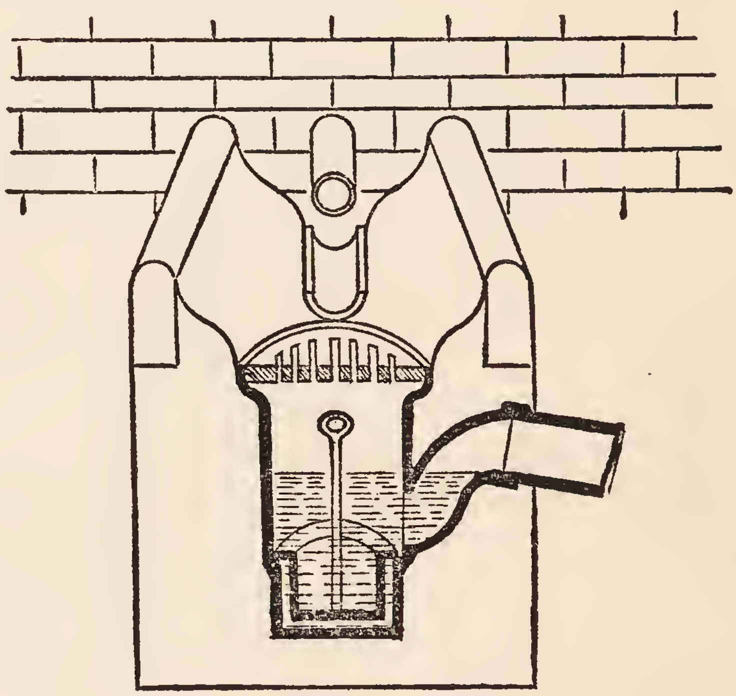


Fig. 41.

The bye-law in question (No. 66, paragraph 4) reads as follows:—
" He shall cause the waste-pipe from every bath, sink (not being a slop-sink constructed or adapted to be used for receiving any solid or liquid filth), or lavatory, the overflow-pipe from any cistern, and from every safe under any bath or water-closet, and every pipe in such building for carrying off waste water, to be taken through an external wall of such building, and to discharge in the open air over a channel leading to a trapped gully-grating at least **18 inches** distant."

The accompanying sketch (Fig. 41) represents an arrangement which is in compliance with the bye-law in question. It will be noticed that this gully is fitted with a bucket, which can be lifted out by means of a handle, so that grease and sedi-

ment in the trap can be frequently and easily removed. It is important that this bucket should be provided with a flange round the top, fitting accurately to the sides of the trap, so as to prevent any dirt falling over the sides when it is being removed.

In connecting a sink placed in the basement storey of a house, which has no area outside the external wall, a convenient plan is to lay pipes from the surface vertically down to the gully, which of course is necessarily a long way below the surface, and to extend the handle of the bucket so that it may be reached from the grating, which is fixed at the ground level. This is not strictly in accordance with the above bye-law, because the waste-pipe must, of necessity, discharge directly on to the gully, but no other arrangement under the circumstances is possible, and as all pipes ought to be trapped within the house, in addition to the outside disconnection, there can be little objection to the proceeding.

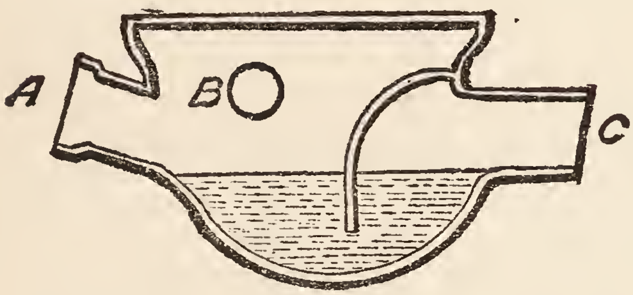


Fig. 42.

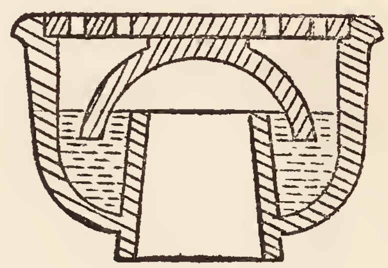


Fig. 43.

Various contrivances are made for the purpose of guarding against the trouble arising from grease being discharged into drains, and thus causing obstruction. The **grease trap,** represented by the drawing (Fig. 42), is recommended for this purpose by Dr. Louis Parkes, from whose book on *Hygiene and Public Health* the illustration (by permission) is taken. The sink water is cooled on coming in contact with the considerable volume of cold water in the trap, the fat is thus solidified, and, being lighter than water it rises to the top, the heavier matters, on the other hand, fall to the bottom. Connected with the inlet, A, is the discharge pipe from an automatic flush tank (see p. 102), which is constantly filling with water, the supply being regulated according to the frequency with which it is considered desirable the flush should take place. Of course the fixing of this appliance is only practicable in the case of large establishments. The effect of this arrangement is twofold; any sediment that may have formed is at once carried away, and the solidified grease, which has collected on the surface, is broken

up, and, being solid, it is carried on by the flush of water in place of adhering to the pipes.

The **bell-trap** (Fig. 43) must be condemned whenever it is met with. Until comparatively recently this form of trap was almost invariably fixed within houses, and very often outside also, although the *dipstone-trap* was the favourite one for outside use.

The chief objections to the bell-trap are the following :—

(1) The shallowness of the water-seal, which is no deeper than about $\frac{3}{8}$ of an inch, and in most instances even less. (2) The tendency to its becoming choked with grease, owing to the smallness of the space between the bell and the waste-pipe. (3) The fact that when the grating is removed (as it often must be, to clear away obstructions), the waste-pipe is untrapped. (4) The fact that the bell is frequently broken off, in which case it

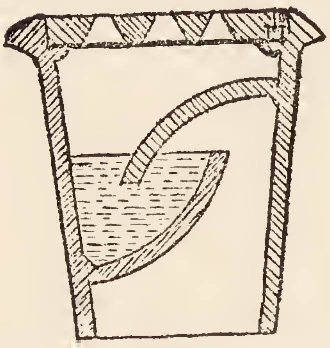


Fig. 44.

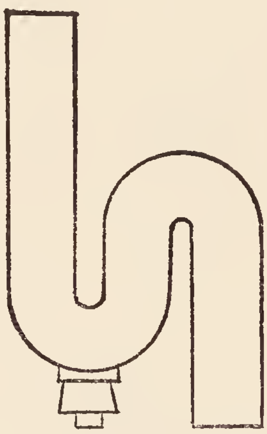


Fig. 45.

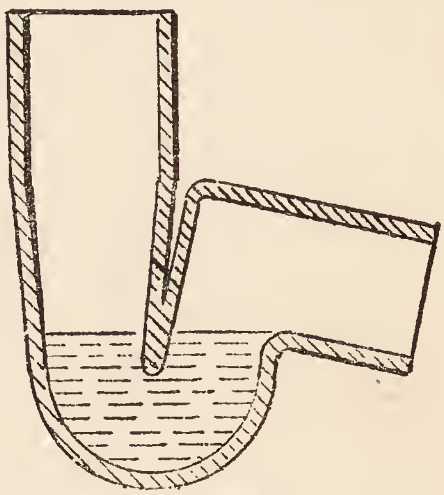


Fig. 46.

no longer constitutes a trap. It is astonishing how often the latter objection is found to apply, and it is by no means uncommon to find that the bell, when it is present, is not deep enough to reach the water in the trap.

Antill's trap (Fig. 44), although a great improvement on the bell-trap, because of the fact that the water-seal is not interfered with by the removal of the cover, cannot be said to be satisfactory, as it is very liable to get obstructed from deposit.

The syphon-trap, or, as it is termed, the **S-trap** (or a modification of it) (Fig. 45), is the only form of trap admissible for waste-pipes. To allow of unstopping it when necessary, an access screw-plug ought to be fixed at the bottom of the lower bend. These traps are not infallible, and in fixing them it is necessary to observe certain precautions, but these will be dealt with in the next chapter.

The anti-D-trap (Fig. 46), which was invented by Mr. Hellyer, is an excellent trap. It will be noticed that the part of it which forms the water-seal is smaller in diameter than the in-go and also that the out-go is enlarged and square in shape. This arrangement is most effective against syphonage.

The dipstone, or mason's trap, is a very objectionable one, in fact it is simply a cesspool on a small scale. The sketch (Fig. 47) shows it in section. It is only necessary to refer the reader to the essential conditions of a good trap (p. 102), to prove why one such as this must be condemned. It is not self-cleansing, neither is it easily cleansed, and probably it will be found that it leaks in all directions, for the workman who is capable of constructing such a trap at all is not likely to realise the importance of making it water-tight. The gully-trap is now so well-known, even in country districts, that, in the case of new work, it is usually employed in place of the above arrangement of bricks and mortar, still one occasionally does meet with such an objectionable form of trap even in new work, and very many may be found in work of an earlier date. The above sketch represents this trap as it is met with on the course of shallow drains, when frequently about one-half the area of the surface is left open, being fitted with a grating to receive the surface drainage of the yard; not unusually, however, the trap is completely covered, an arrangement which is still more objectionable, as the foul deposit which collects in it will rarely be removed.

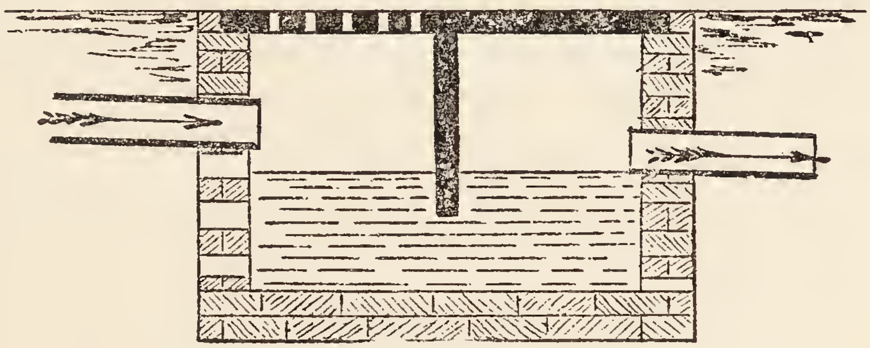


Fig. 47.

Another bad form of trap is the **D-trap** (Fig. 48). It is usually met with in connection with soil-pipes, although, now, the syphon-trap has entirely superseded it. Its defects are perfectly apparent, there are too many sharp angles and projections which prevent its being self-cleansing.

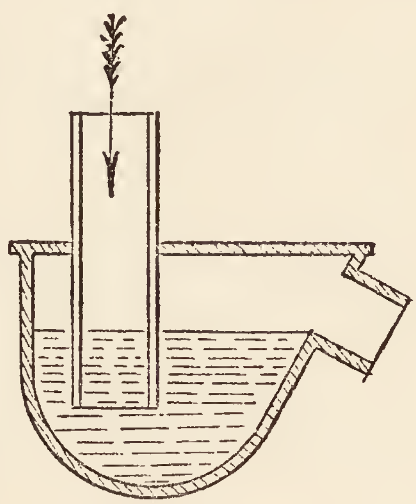


Fig. 48.

It will be necessary to refer to some of these traps again, in connection with the details of plumbing; but it will be convenient here to call attention to certain important conditions with which all traps must comply in order to fulfil effectively the purpose for which they are intended. They must impose a sufficient and constant barrier or seal against the passage of sewer gas, and they must be self-cleansing. The first condition necessitates a depth of water-seal of at least $1\frac{1}{2}$ inches, and the second, the absence of all angles, projections, or cavities that may interfere with a free flush, and lead to the deposit of solid matter, which would immediately decompose and cause a nuisance. All drain-traps, as already stated, must be outside the house, and so connected with the drain that in the event of sewer gas forcing its way through, it would escape into the open air, and not into the house.

The erroneous belief, among the public and ignorant workmen, that perfect safety is afforded by a trap, is responsible for many grave defects in house drainage. These defects have already been noticed in detail in describing the different kinds of traps in use; but there are certain dangers, against which all traps, however perfect in design, are more or less inoperative.

1. A trap may cease to be a trap by reason of disuse, owing to the evaporation that takes place from the surface of the water. This is a consideration that has to be thought of in connection with any drain that is only in use at intervals, and some provision should be made for renewing the water in the trap.

2. A trap may cease to be a trap by the water it ought to contain being sucked out by syphon action. This is a danger that can be guarded against by connecting an air pipe with the top of the trap, beyond the seal, and by other means already mentioned.

3. Pressure of foul gas within the drain may force the water-seal. This danger may be guarded against by proper ventilation of the drain, sewer, or cesspool as the case may be.

4. Sewer gas may be absorbed by the surface of the water on one side of the trap, and discharged from the surface on the other. The more perfect the self-cleansing action of the trap, and the better the drain, sewer, or cesspool ventilation, the less likely is this to occur.

5. As all traps necessarily impose a certain amount of obstruction to the flow of sewage in the drain, they tend to cause stoppage, and for this reason ready means of access to them should be provided (see p. 89).

Automatic flush-tanks are excellent contrivances, by means of which drains and sewers may be regularly flushed, a proceeding which under all circumstances is desirable and often essential. Drains and sewers ought to be laid with a sufficient fall to be self-cleansing under the conditions of an ordinary flow of sewage,

but this is not always possible, in which case the flow must be periodically supplemented by some other means.

Field's flush-tank, shown in section (Fig. 49), has been designed for this purpose, and answers admirably. It may be constructed to hold any quantity of water, in accordance with the size of the drain or sewer which it is intended to flush, the diameter of the outlet being regulated accordingly. Tanks of this description which are connected with large sewers are mostly built in brickwork, but those for drains and smaller sewers are usually made of galvanised wrought iron. In the case of private drains, the usual capacity of such a tank is from 80 to 100 gallons, the diameter of the discharge-pipe being 4 inches. The automatic discharge is accomplished by means of the syphon arrangement in the interior. Passing through the floor of the tank is a pipe which is open at both ends; the lower end terminates in a

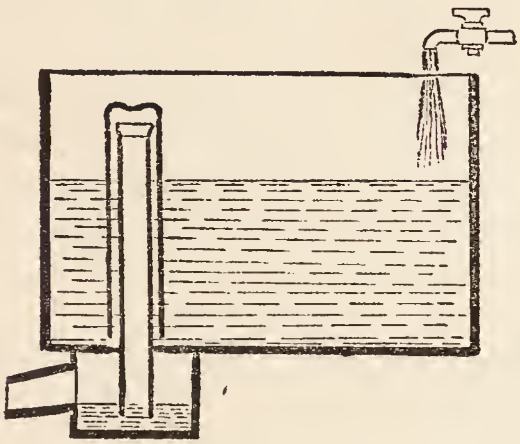


Fig. 49

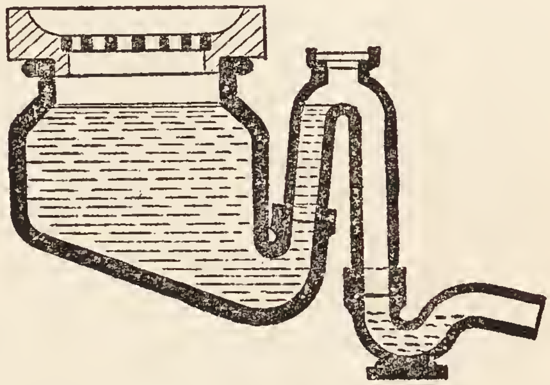


Fig. 50.

chamber underneath, containing water into which it dips, and in the interior it is surrounded by a cap which does not reach quite to the bottom of the tank. This constitutes the syphon. A tap is connected with the tank, and the flow of water is regulated in accordance with the length of interval it is intended should elapse between each discharge. The syphon action is started in the following manner:—As the tank fills, the water ascends between the inner and the outer pipes, displacing the air down the central pipe, through the water in the lower chamber. When the water has risen to the top of the central pipe, it begins to fall down into the lower chamber, carrying with it a certain quantity of air; in time, by this process, a sufficient vacuum is established within the pipe to cause the pressure of the atmosphere to force the water from the tank into it, and thus, syphon-action being started, the tank is rapidly emptied through the

outlet from the lower chamber which is connected with the drain. In order to encourage the formation of the vacuum, the top rim of the central pipe is curved inwards, so that the water, in place of trickling down the sides, falls freely down the centre. For this reason, it is important in fixing the tank to notice that the syphon is perfectly upright.

These tanks answer perfectly, however small they may be, for flushing with clean water, and the larger ones may be used for sewage water, in connection with the sub-irrigation treatment (see p. 169); but when used, as they are sometimes, for collecting and automatically discharging into the drains the sink or laundry waste of an establishment, they are very likely to fail from clogging.

A better form of flush-tank for the latter purpose, although it will not discharge by means of a drop feed, is **Adams' flushing gully** (Fig. 50).

There is one condition common to all syphon flush-tanks, and that is, that should there be a second trap in the line of drain with which the tank is connected, it must either be removed or an air-break must be introduced between it and the tank.

In the construction of a **water-closet,** attention ought to be paid to the following points :—

1. It ought to be placed next an outside wall, and, if possible, separated from the house by a passage with cross window ventilation, the closet itself being provided with a window for ventilation.
2. A perfect water flush must be provided. This must not be taken from any cistern for supplying drinking water, nor service water-pipe, and should be sufficient to entirely remove the excreta, and nothing in the construction of the closet should tend to interfere with this complete removal.
3. The soil-pipe should be outside the house, a water-seal being interposed between it and the closet, and it ought to be so constructed as to allow of the free passage of air through it.
4. The drain that removes the water-closet waste, if connected with a sewer, need not necessarily have a trap interposed, but if with a cesspool it must be trapped, although it is not essential to provide an air inlet on the house side of the trap.*

The following varieties of water-closets are met with :—**the valve, the wash-out, the wash-down, the plug,** and **the pan.**

The following description of these forms has reference only to their construction, and in discussing their merits or demerits it must be remembered, that while a bad form of closet cannot by any process be made sanitary, a good closet may be rendered insanitary by errors in fixing. In other words, a bad closet

* See page 83.

cannot be made a good one, and a good closet may be made a bad one ; the plumber cannot rectify the faults arising from a defective design, while he may defeat the objects aimed at in a good design. The details of fixing will be dealt with in the next chapter.

The valve closet (Fig. 51) is an excellent appliance, provided economy is not considered ; but, as there is a certain amount of mechanism in its construction, unless the best quality of workmanship is obtained, faults will very soon become apparent.

The simplest **wash-down** closet, of good design, is much to be preferred to a cheap valve closet.

The valve closet, apart from the fittings, consists of an earthenware enamelled basin, A, which is kept about two-thirds full of water by means of a valve, B, at the outlet. The water flush is connected with the rim of the basin, which is turned inwards upon itself, C, so that the discharge passes all over the surface, in place of being distributed over one side only, as is the case with the *fan spreader*. By means of a "pull" the valve is depressed within box D, which is connected with the basin above, and with the soil-pipe trap below, and thus the water and the contents of the basin are discharged through an opening 3 inches in diameter into the soil-pipe. The valve-box, which ought to be made of cast iron, enamelled in the inside, is connected with the trap by means of a short **conducting pipe,** E. A lead overflow pipe, F, with a properly-constructed syphon-trap, G, connects the basin with the valve-box below. Valve closets without overflows are now fixed not infrequently ; in such a case, in the event of accident the basin overflows into the safe-tray.

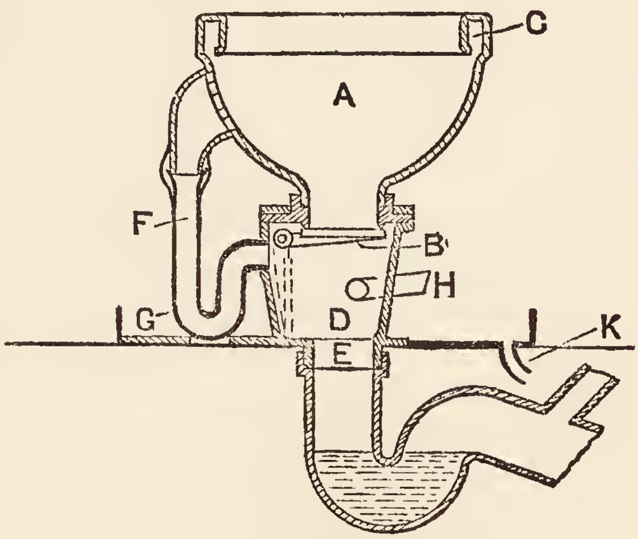


Fig. 51.*

It is also important to ventilate the valve-box by a pipe, H, which should be carried through the wall at a convenient point a few feet away from a window, where it should be cut short and left open to the air. It is not necessary to continue this air-

* The anti-syphonage pipe should be directed upwards and forwards before passing backwards through the wall ; obstruction is likely to take place if it is directed as in the drawing (see Fig. 83, p. 138).

pipe upwards above the roof, the closet being self-cleansing, and the soil-pipe being ventilated. With a valve-box not so ventilated, the syphon-trap of the closet overflow is liable to be unsealed by the rush of water through the conducting pipe, E, when the closet is used, particularly if the pan has been filled up to the brim. Any foul air that may be generated in the closet-trap if the handle of the water-closet should be carelessly pulled so as not to allow of the free flush of the trap readily escapes by this pipe.

It is convenient to connect the overflow pipe with the valve-box ventilator, and there is no objection to such a proceeding.

Upon the floor under the closet, a *safe* or tray should be fixed to prevent injury to the floor, or the ceiling below (if the water-closet is on an upper floor), in the event of the overflow of the basin (if it has one) becoming stopped, and the supply valve becoming defective, or any other accidental circumstance that might cause leakage. The construction of this safe, and the arrangement of its overflow, will be described in the next chapter.

The pan closet (Fig. 52), now, happily, only met with in old houses, is a very different piece of mechanism to the above, and ought, when met with, to be unhesitatingly condemned.

The drawing shows it as it is almost invariably seen connected with a D-trap (see p. 101). A moment's reflection will make it apparent how thoroughly filthy the whole arrangement is. The basin, in this case, A, is fixed within a large cast-iron vessel called **a container,** or more properly receiver, B. The outlet of the basin is into a movable copper pan, from which the closet takes its name, and which sustains the water in the basin. By raising the "pull" of the closet, this pan describes a semi-circle within the container, until it reaches the point marked D within the dotted lines, and its contents are suddenly discharged into the trap underneath the floor, with which the container is

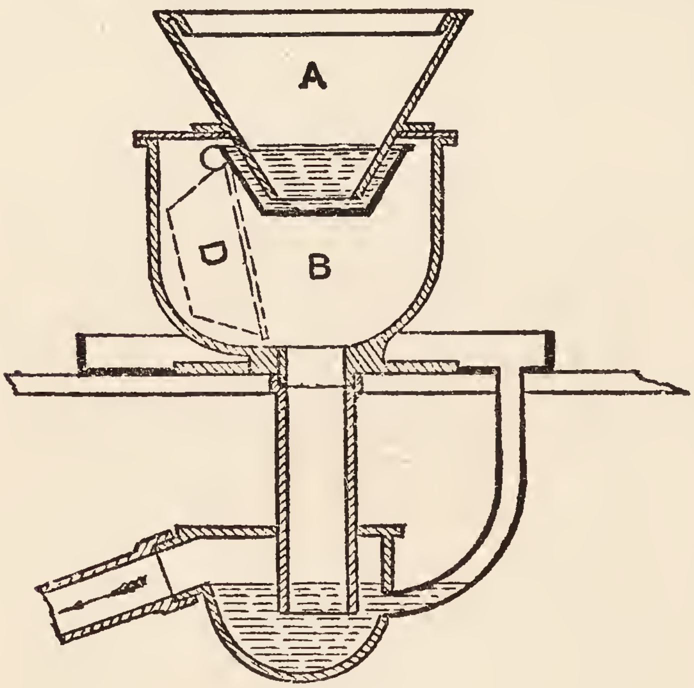


Fig. 52.

connected, causing splashing all round the interior of the container, and on the under surface of the pan. To realise the disgusting effect produced, one must see the interior of such a closet which has been in use for some time, and it will then become apparent why a foul smell should be given off every time the closet is used, for at that time no water-seal exists between the basin and the container. Apart, therefore, from the usual insanitary conditions found in connection with this form of closet, in itself it cannot be otherwise than unwholesome.

The plug closet, represented in section (Fig. 53), is also known as the **trapless** closet. The water-seal in this case is maintained by means of a plug, A, which is contained in a side chamber, B C, from the top of which an overflow passes down to join the

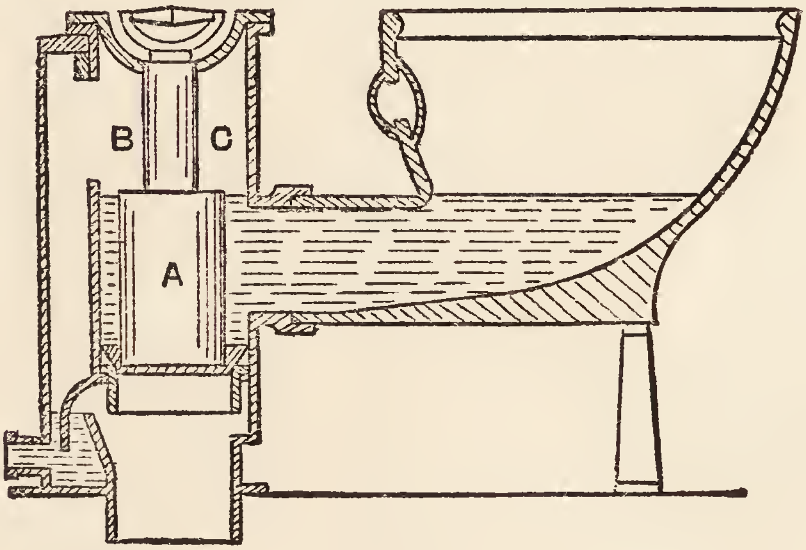


Fig. 53.

soil-pipe below the plug, or, as is sometimes the case, the overflow, trapped by an S-trap, passes through the centre of the plug. It is not a safe proceeding to connect one of these closets direct with the soil-pipe, but, like the valve closet, it should discharge into a syphon-trap, otherwise, foul air will pass into the apartment from the soil-pipe when the closet is in use. Also, should any substance, such as paper or a match, get lodged between the plug and its socket, and so allow the water forming the seal gradually to pass away, the soil-pipe would then be in direct communication with the house. Another objection to the plug closet is, that owing to splashing, the plug chamber above the plug becomes foul, and an offensive smell may pass into the apartment through the opening for the plug handle. This difficulty has been overcome by Jennings, who, in his new plug closet, has abolished the upper part of the chamber, and carried

the plug-rod upwards to the handle by means of an open skeleton frame-work.

The **hopper** and the **wash-out** closets are all constructed very much on the same general principles, although they differ in important details. Both are made of stoneware, as is the **S**-trap, into which, in the former case, the excreta fall direct. The sketches (Figs. 54 and 55), which represent in section the **long** and the **short** hopper, require little or no description, as they speak for themselves.

The short hopper is undoubtedly a great improvement upon the long one, by reason of the fact that it has a smaller area of basin to flush, consequently the contents are more thoroughly expelled, and fouling is less likely to occur. The short hopper is well adapted for an outside water-closet, or one on the ground

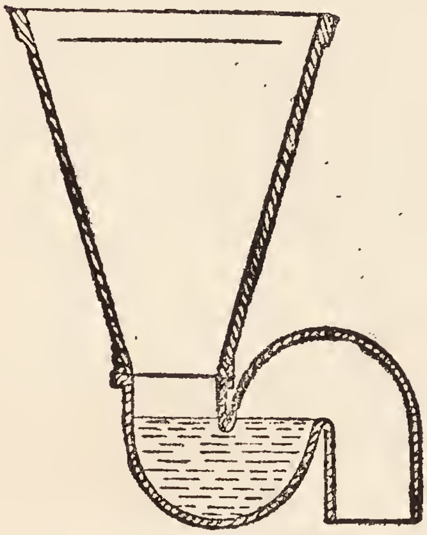


Fig. 54.

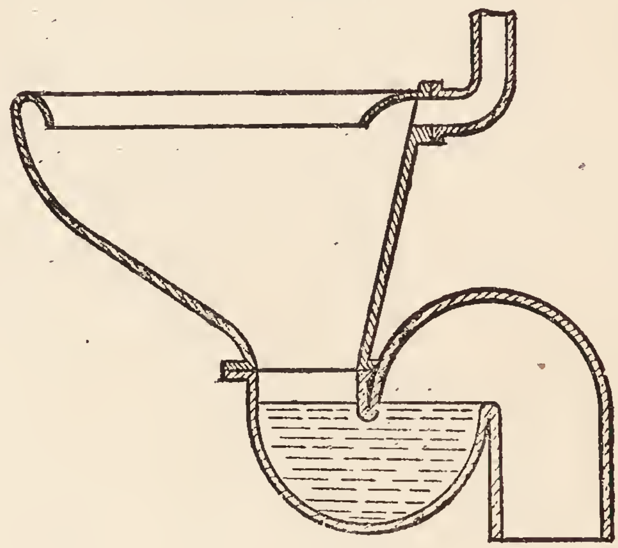


Fig. 55.

floor, where it can be connected with the drain without the intervention of a lead soil-pipe ; but for upstairs water-closets there are difficulties associated with the junction of the stoneware trap and the metal soil-pipe, which militate against this particular design ; these, however, will be dealt with more fully in the next chapter.

The **wash-out closet** (Fig. 56), which until recent years was fixed in so many houses, differs from the short hopper chiefly in two respects—the basin and trap are constructed of one piece of stoneware, and the former is shaped so as to form a shallow container for water, into which the excreta fall and over the ledge of which they are discharged by means of the flush into the syphon-trap below. Of course the object of introducing this shallow dam of water is to prevent the fouling of

the basin by excreta, but although it may have that effect, it is acquired at the expense of other and important requirements. In the first place, the interruption of the downward flush leads to the partial emptying of the trap only; and, secondly, the splashing of the water against the wall of the basin above the trap causes portions of fæcal matter to be deposited on the sides in a position beyond convenient reach for cleansing. This, in time, causes the glaze to crack, and so by converting what ought to be a non-porous into a porous surface the mischief is added to. The effect of both these faults is to produce a condition of things that is hardly less objectionable than that described in the case of the old pan closet. The mixture of urine and fæcal matter which remains in the trap after the flush leads to a deposit being formed on the sides, which soon begins to decompose, and each time the closet is used a certain area of this deposit is exposed, with

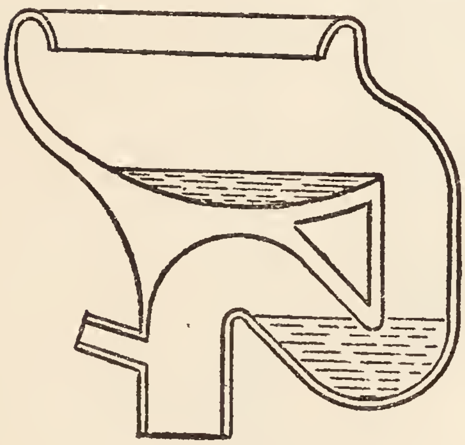


Fig. 56.

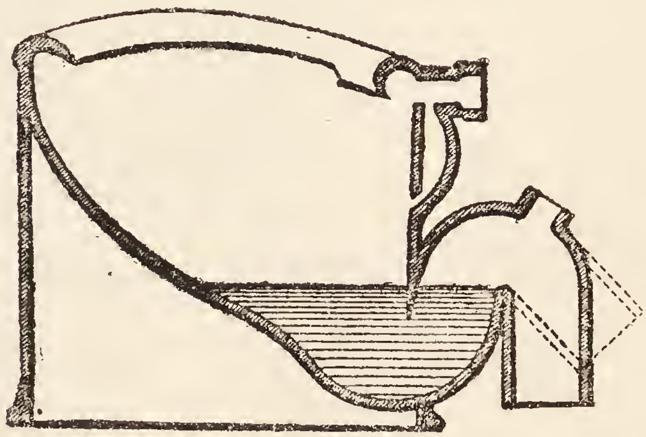


Fig. 57.*

the result that foul odours are given off. But, in addition to this, the part immediately above the trap, which is freely exposed to the air of the apartment, and which, as already stated, in time becomes coated with filth, is alternately wet and dry, and constantly gives off offensive odours. Any one can satisfy himself with regard to the accuracy of these assertions, by lifting the closet seat and holding a lighted taper above the water-seal and by placing his nose moderately close to the basin.

It is a fact that hundreds of these closets are removed yearly from London houses, on account of the nuisance arising from the conditions described, and the author has frequently had to advise the same course in the country, sometimes when the apparatus has only been in use for 12 months, and with a 3-gallon flush. A closet of this description with a 2-gallon flush (all that

* As regards the anti-syphonage pipe, see footnote, Fig. 51, p. 105.

is permitted in most towns) will not thoroughly flush the trap on all occasions, or even usually, and a 3-gallon flush will not do so in the case of all closets constructed according to this pattern.

In contradistinction to the *wash-out*, what is termed a **wash-down** closet (Fig. 57), which, as regards design, is practically a short hopper, except that it is made in one piece of stoneware, is now largely used. In some of these, of modern make, a 2-gallon flush will almost invariably, and a 3-gallon flush will invariably, with proper use, leave the trap free from paper or excreta, and they are not open to the objection arising from splashing. In fact, this design of closet, if properly constructed after the fashion shown in the drawing, with a good depth of seal, and a sufficient surface area of water to provide against fouling of the surface of the basin by excreta, and fitted in accordance with the rules laid down in the next chapter, compares favourably with any,

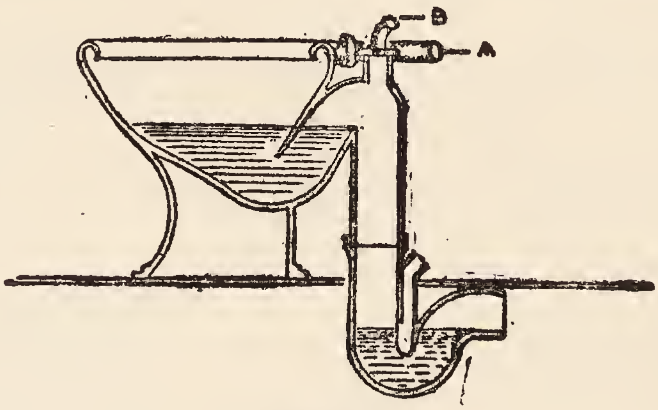


Fig. 58.

including the **valve closet**, and it has the advantage over the latter that it costs less than one-half.

Recently another form of water-closet has been brought out by Jennings of Lambeth, called the **century closet** (Fig. 58). It has taken the place of another closet, called *the Dececo,* which it resembles in principle, and although it is an expensive appliance, it must be admitted that it is cleanly and has points in its favour which the latter closet did not possess. The feature of this closet, like the one it supplanted, is that the ascending arm of the syphon-trap is continued upwards, so that the water in the basin stands at a higher level, and consequently a larger area is exposed, and a deeper seal is formed; also, the descending arm terminates in a second syphon before it joins the soil-pipe. It will be noticed that this arrangement practically corresponds with the construction of the automatic flush-gully described on p. 104, and, as a matter of fact, its action is identical. Syphon

action is started with the inflow of water from the supply cistern, both by the pipe, A, passing to the rim and by the pipe, B, discharging into the descending arm of the syphon, and the contents of the basin are rapidly **extracted** by that means. Since the century closet was introduced, others very similar in design have been brought out by other makers.

In selecting a closet it is important to remember the following points :—(1) As regards the valve closet, only the best quality, and, therefore, the most expensive, is likely to give satisfaction. (2) The plug closet cannot be strongly recommended, but none are satisfactory that have the long chamber for the plug, and all must be fixed with a syphon-trap. (3) Avoid a closet with too

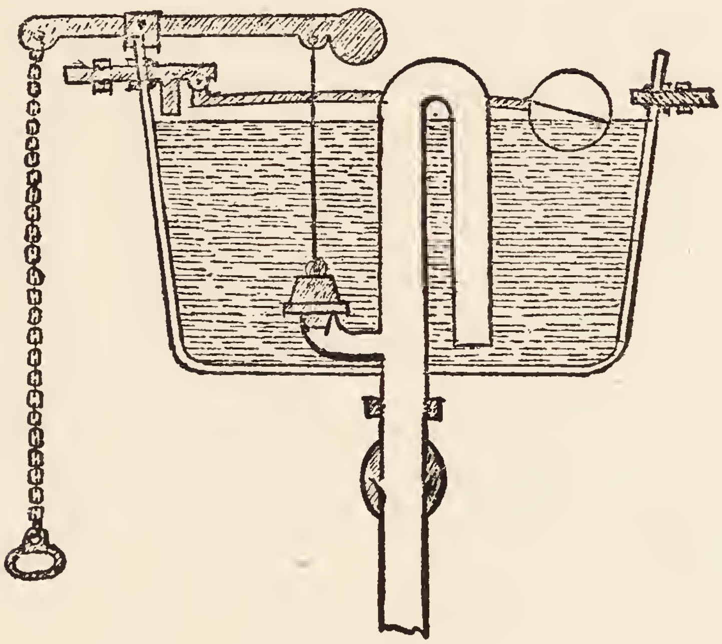


Fig. 59.

long a basin. (4) On no account select a *wash-out*, but if one of that class be decided upon, let it be a *wash-down*. (5) Be careful to notice the plan for connecting with the soil-pipe, according to the cautions mentioned on p. 129, *et seq.*

Special cisterns for supplying the water-closet flush must always be provided (see p. 24), and in most towns what are termed water waste-preventers, which discharge 2 gallons at a time, are insisted upon. From what has already been said, it will have been understood that this quantity is hardly sufficient even for closets of the best construction, and for any other it is far too little. Whenever possible, therefore, it is advisable to fix a cistern which delivers 3 gallons.

There are many kinds of **water waste-preventers,** as they are termed. The drawing (Fig. 59) represents one which discharges

by syphon action; it is simple in design, and requires little description. The water supply is regulated by a ball-tap, and syphonage takes place when the plug is raised by pulling the handle. When once syphon action is started the whole of the water will be discharged, whether the handle is liberated or not.

These cisterns are generally made of cast iron, and, to prevent rusting, they should be galvanised. The formation of rust is very objectionable as it causes staining of the closet basin. For this reason, cisterns are sometimes made of wood with lead lining, and these are certainly to be preferred to the cast-iron ones although they are a little more costly. In selecting a cistern it is important to notice whether it is silent in action, as many of them are very much the reverse, and give rise to complaints in consequence. Often, however, this is not so much the fault of the cistern as of the plumber who fixes it.

A cistern of the water waste-preventer type is not suited for a valve closet, but an ordinary cistern with a ball tap should be used, the flush being regulated by what is called a **supply-valve and bellows-regulator,** an apparatus which is worked by means of the closet pull. By turning the stop-cock on the bellows-regulator, the rate at which the air escapes may be controlled; and as it is upon this that the amount of water delivered depends, it is possible to adjust it for a large or a small flush. Another advantage is that with this apparatus several flushes may be given in rapid succession, and this is why water companies object to it, although, according to Mr. Hellyer, "a good supply-valve and regulator is not likely to waste so much water as nine-tenths of the so-called water waste-preventers." The drawing (Fig. 60) will assist the reader in understanding this appliance. The regulator in this instance is fixed on a cast-iron frame separate from the closet, but closets are to be obtained with the whole apparatus attached. In the figure, A represents the bellows-regulator which is made of copper. The small tap at the top is for the purpose of regulating the pace at which air can pass out of the bellows, and it is this which determines the amount

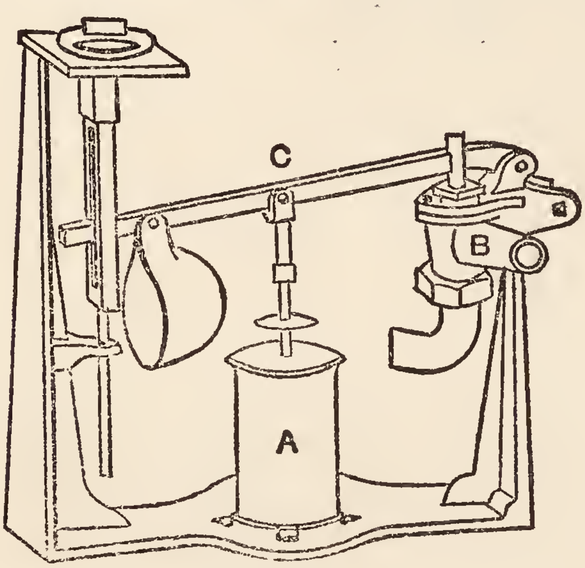


Fig. 60.

of water that is discharged into the basin. By turning the tap so that the air passes through slowly, the weighted lever, C, takes longer to descend and close the supply-valve, B, and until this is closed water will continue to be delivered from the cistern. If the cistern is placed as high as 4 feet above the closet, a 2-inch pipe, connected with a $1\frac{1}{2}$-inch supply-valve, will supply a sufficient flush, but if the height is only a foot or two, then a larger valve is necessary.

The **trough-closet** (Fig. 61) is suitable for manufactories, and, possibly, for blocks of buildings; but, although many have been provided for schools, their use in such buildings cannot be recommended for two reasons—first, because the flush, being intermittent and automatic, the closet must frequently be used before the excreta and urine of the previous users have been

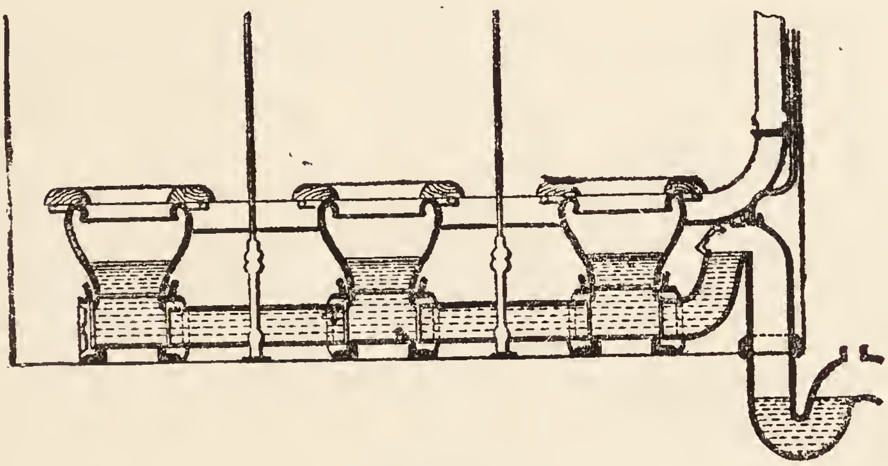


Fig. 61.

removed; and, secondly, because it affords a bad object lesson for the children. The proper use of sanitary appliances should form part of the educational system, and, for that reason alone, the closets provided for schools should be of the type approved of for houses—that is, each should be provided with a hand flush. It has been contended that the children, especially the younger ones, cannot be taught to flush the closets after use, but it has been proved that this is not the case, providing teachers take a practical interest in this branch of the training, which, of course, it is their duty to do. This form of closet may be said to be a combination of wash-out closets with a common flush. It consists of a trough, usually of stoneware, which extends from one end to the other of a series of closets, which are simply compartments formed by partitions, each having an opening into the trough, and the whole being under one roof, and freely

ventilated. The form shown in Fig. 61 is a great improvement on the original trough-closet, which consisted of a trough only, no rim-flushed hoppers or basins being introduced. Connected with the rim of each basin or hopper is a pipe from an automatic flush tank, similar to that described on p. 103, which is fixed about 5 feet above the closet seats. Each closet is trapped by the hoppers dipping into the water in the trough, and there is a common trap cutting off the latter from the drain. The size of the flush-tank depends upon the number of closets on the system, and the frequency of the flush is regulated by the tap on the supply-pipe.

The trough-closet system is only admissible on a large scale in towns with ample water supplies and favourably situated for dealing with the sewage. It may be essential, however, to exercise economy in the consumption of water, owing to its scarcity, or because the surroundings necessitate a pumping scheme, or because ample land is not available, in which case the introduction of the trough-closet system on a large scale may not be expedient.

In many districts **slop-water** has long been used as a flush for the old hopper closet, the waste-water being simply collected in buckets, and tilted by hand into the pan. The more approved system now in use was first introduced many years ago by Dr. Alfred Hill of Birmingham, and since then hundreds of slop-closets have been fixed in that town.

Some years later considerable improvements were effected in their design, and other towns have adopted the system, which, although not ideal, compares favourably with the privy or pail systems.

There are several varieties of slop-closets, but Duckett's, Allen's, and Day's are those usually met with.

Duckett's closet (Fig. 62) consists of an oval pan, which reaches from the wooden seat to the drain, the depth varying in accordance with the distance of the drain from the surface.

Immediately under the pan is a chamber, the floor of which has an annular arrangement for retaining a certain quantity of water. This chamber opens below into a syphon trap which is connected with the drain. The sink pipe discharges on to a gully in the usual manner, the outlet from which is connected with a **tilting vessel** or **tipper** holding 3½ gallons. This tipper, which may receive other house connections, if necessary, is balanced on brass bearings, so as to cause it to tip over when full, and discharge the whole of its contents suddenly into the closet-trap.

Allen's closet (Fig. 63) is constructed much on the same principle, except that the closet pan is connected with the top of

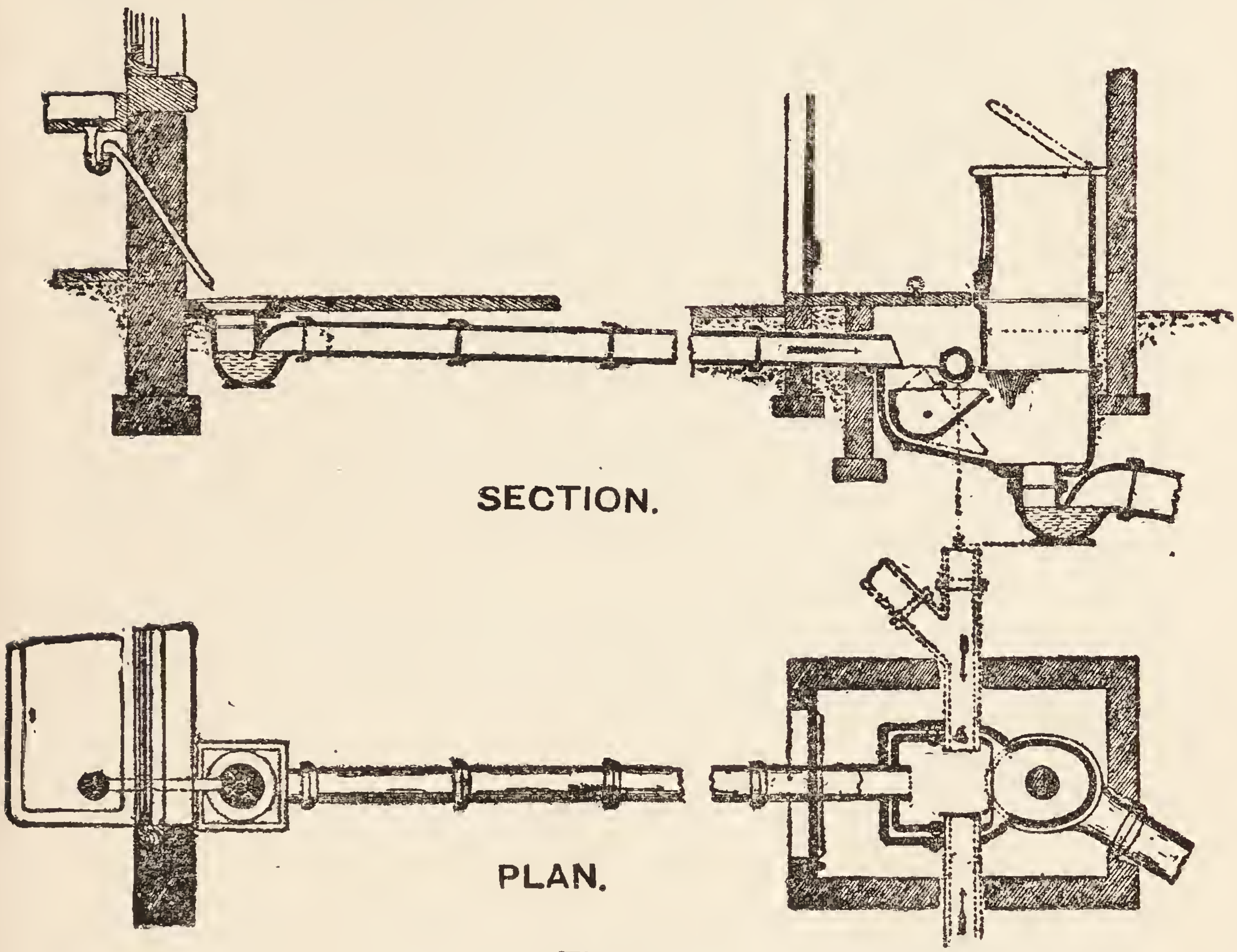


Fig. 62.

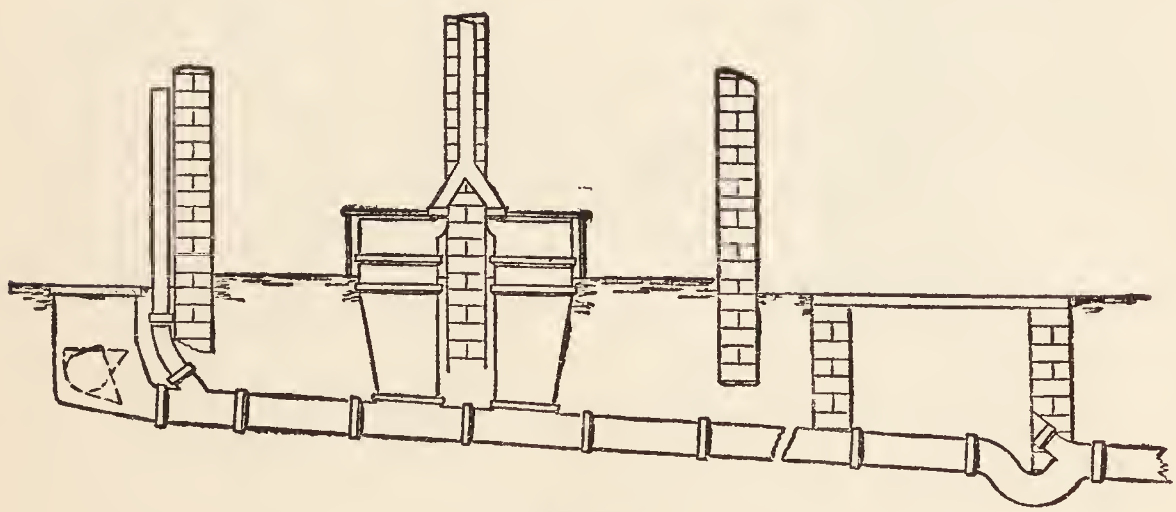


Fig. 63.

the drain (or sewer, see Appendix), without the intervention of a syphon. Several closets may thus be connected, the flush

being supplied by a tipper at the top end receiving the drainage of the houses, and a manhole, with syphon-trap and raking-arm (see p. 92), is placed at the outlet into the main sewer. The manhole cover is open, and the top end of the drain, or tributary sewer, is ventilated by a 4-inch pipe carried up above the roofs of the houses; a ventilating pipe is also carried from the top of each of the closet-pans.

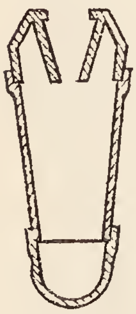


Fig. 64.

To guard against the risk of stoppage of the drain, from large articles being thrown into the closet, an arrangement, shown in small section (Fig. 64), is fixed on the top of the closet-pan. It consists of two converging plates, which are directed downwards for some distance, and approach each other in the middle, so as to form a longitudinal opening, the long axis of which extends across the pan from front to back, the transverse measurement of the opening being about $2\frac{1}{2}$ inches.

The drawing (Fig. 65) represents Day's slop-closet, a form of closet which, some years ago, came much into favour among advocates of the slop-closet system.

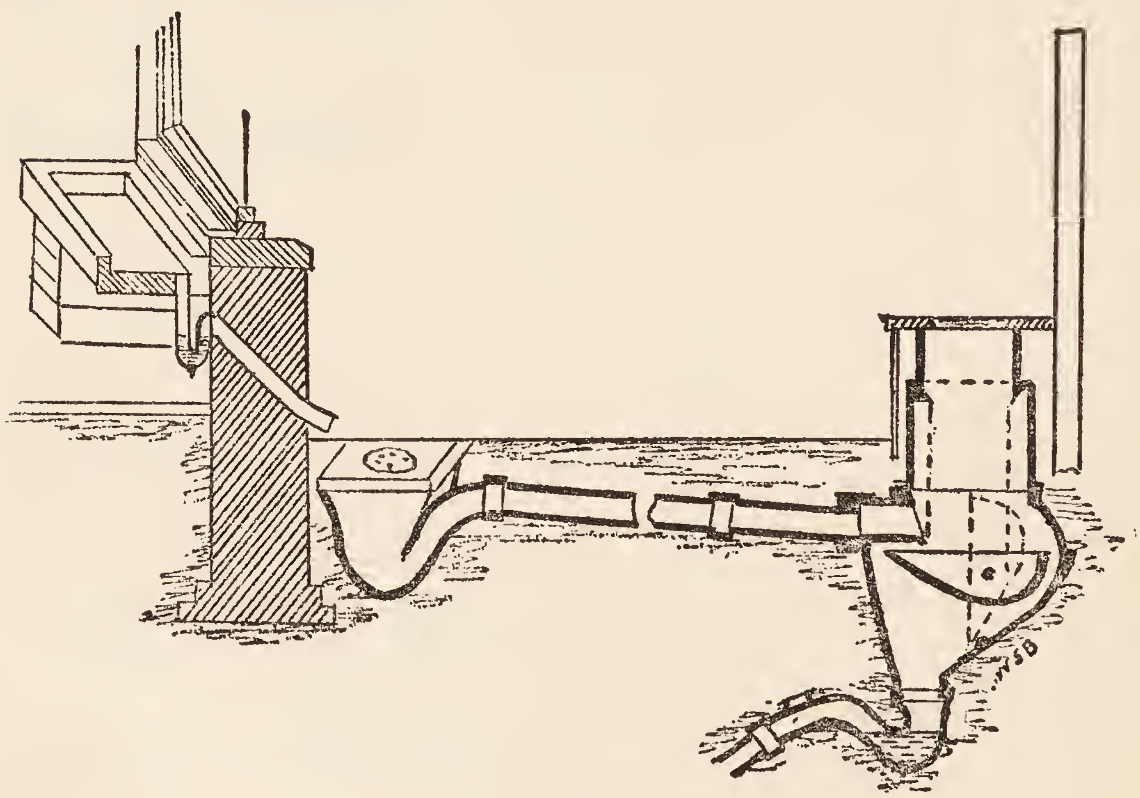


Fig 65.

The chief features of the apparatus are:—(1) The tipper is the receiver for the excreta, and it discharges directly over the syphon-trap; and (2) each section of the connecting shaft between

the pedestal and the container for the tipper has an increased diameter from above downwards, an arrangement which lessens the risk of matter adhering to the sides. Many of these closets have been fixed in Wolverhampton and neighbourhood.

There are other forms of slop-closets, but the three that have been described may be considered typical of the rest.*

As regards the slop-closet system from a sanitary point of view, much difference of opinion prevails. All are agreed, however, that the system will compare very favourably with the privy-midden, or even the pail system of excrement removal, at the same time, from a cleanly point of view, slop-closets are undoubtedly inferior to ordinary water-closets.

Arguments for and against the Slop-Closet System.

The question whether the slop-closet system may be accepted, on general sanitary grounds, as a satisfactory way out of the difficulty in the case of towns where the privy or pail systems are in operation is one which is by no means settled, and authorities, in their efforts to remedy existing evils, must be careful to avoid creating others. It may be well, therefore, to consider the arguments for and against the system as compared with the ordinary water-closet system.

As regards the cost of introduction, it may be accepted as a fact that there is little to choose between them, but the annual expenditure is certainly less in the case of slop-closets.

The following are the chief arguments arranged categorically :—

Arguments for.—1. The trouble and expense entailed by the freezing of pipes and cisterns in the case of outdoor water-closets need not be considered in the case of slop-closets, as experience has shown that, apart from the temporary inconvenience arising from frozen gullies (a trouble which is easily rectified), frost does not affect the working of the system.

2. By utilising the slop-water of a household for flushing closets, considerable economy is effected in the consumption of water, providing the supply is honestly used and the taps are not allowed to run simply as a means of flushing the closets.

3. The volume of sewage to be dealt with is greatly lessened—an important consideration, especially in towns where it has to be pumped to the disposal works.

* See report on slop-closets and trough-closets, by Dr Parsons, "Twentieth Annual Report of the Local Government Board" (Supplement), 1890-91.

4. Experience has shown that with proper and systematic inspection—a condition common to both systems—the trouble arising from carelessness on the part of persons using the closets is, possibly, not greater in the one case than in the other.

Arguments against.—1. Slop-closets are certainly not so cleanly as ordinary water-closets, but for outdoor purposes probably no very serious objection can be raised against them on this score, provided arrangements are made by the authority for efficient supervision.

2. Undoubtedly if slop-closets were generally introduced, the difficult question of drain and sewer ventilation would be greatly complicated, partly because of the lessened flushing power of the sewage, owing to its diminished bulk, but mainly owing to the rapidity with which putrefaction takes place in such sewage, a considerable portion of which, especially during the night, must have remained in the tippers for some hours.

3. The general introduction of slop-closets in many cases would add to the difficulties of sewage disposal, owing to the highly concentrated nature of the sewage and the want of aëration, consequent upon the absence of a clean water-closet flush, and upon the fact that most of the fluid contributing to the flow has been boiled. This difficulty, however, has been lessened by modern methods of disposal. It must be remembered that flushing of the closets by allowing the taps to run does not uniformly dilute the sewage, as it is generally during the night, when the sewage flow is at its lowest, that the water is left running.

4. Experience in certain towns where this system has been largely introduced has proved that the objections raised by the Water Companies to its introduction have by no means been ill founded, as it undoubtedly does lead to a considerable waste of water in many cases.

5. Nuisance frequently arises, and house drains often become obstructed owing to the misuse of such closets by careless people who frequently make use of them as receptacles for solid house refuse—broken crockery, brick ends, etc.

In weighing the arguments for and against the slop-closet system, it must not be forgotten that some of those which tell against it are largely attributable to the absence of efficient inspection. Authorities who adopt the system must face the necessity of systematic inspection at short intervals, and appoint inspectors specially for that purpose. When first introduced, the system, from the point of view of the Sanitary Authority,

appeared to be both efficient and economical, but practical experience has shown that this is not quite the case. If we could ensure that the closets had proper attention, no doubt little trouble would be experienced, but among the working classes it is the exception, not the rule, to meet with persons who will take the slightest trouble to look after any appliance, however simple, the majority being content to let matters slide until the time comes when it is beyond their power to remedy what might in the first instance have so easily been prevented.

When the system was first introduced it was thought that it would prove to be a simple solution of the vexed question of water carriage *versus* conservancy methods. Probably, however, most of the Authorities who were enthusiastic advocates of the system in the first instance, have since had reason to doubt whether they were well advised in adopting it. It is true that in districts where it has been in operation a considerable annual saving has been effected, even in cases where the cost of its introduction has been defrayed by the Authorities, but economy should not be the first consideration, and, while all are agreed that the conservancy method in towns must be discarded, it is daily becoming more and more apparent that the water carriage system proper is the only alternative.

On the whole then, for the reasons given, it is more than doubtful whether the disadvantages of the slop-closet system do not outweigh its advantages.

Effect of Frost on Outdoor Water-Closets.

As regards the actual injury resulting from frost in the case of outdoor water-closets, there is considerable difference of opinion among engineers, and it is most desirable, in view of the preceding arguments, that facts bearing upon the subject should be collected.

During the severe frost in the winter of 1895, the author instituted an inquiry in two towns in Staffordshire (A and B), the results of which are shown in the table on p. 120.

Of course, no reliable conclusions can be drawn from one set of observations, and it is only by repeated inquiries, in many towns, and under varying conditions of frost, that satisfactory evidence can be obtained; still, the figures are given for what they are worth, and they point at least to one interesting conclusion—namely, that the injury resulting from frost may differ greatly in different towns. It will be noticed that in the case of town

A the percentage of frozen pipes which burst was more than six times greater than in town B, a circumstance which can easily be explained, for in the former town the water-carriage system had long been in operation, and the plumbing work was of the most inferior description, whereas in the latter out-door water-closets had only lately been introduced, and the plumbing work was much more substantial. It will be noticed that although the bursting of pipes was excessive in town A, the percentage freezing was less than in town B. This is probably explained by the fact that in the former case the water supply was an old gift to the town, and only a nominal charge was made for it, in consequence of which the cistern pulls were frequently purposely fixed to allow the water to flow continuously during the frost, whereas, in the case of town B, no such licence was allowed. The difference in this respect is shown by the relative percentage of precautions adopted in each case, most of which were of this nature.

		Frozen.	Per cent.	Fractured.	Per cent. of Whole	Per cent. of Frozen.
Town A, 157 Observations,	Supply pipes,	119	76	30	19	25
	Cisterns, . .	112	71	9	5·7	8·0
	Pans, . . .	157	100	3	1·9	1·9
Town B, 201 Observations.	Supply pipes,	196	97	8	3·9	4·0
	Cisterns, .	180	89	6	2·9	3·3
	Pans, . . .	201	100	4	1·9	1·9

Percentage precautions, $\begin{cases} \text{Town A} = 12·0 \\ \quad\text{,,}\quad \text{B} = \ 1·5 \end{cases}$

Drainage of Slaughter-Houses, Cowsheds, Stables, and Piggeries.

The general requirements in these buildings are defined in the model bye-laws (see Appendix), but it may be well to describe a little in detail how they should be drained.

All slaughter-houses, cowsheds, and stables should be disconnected from the drains—that is, no trap should be placed within the buildings. The floors should be laid in impervious material, such as brickwork set in cement on a bed of concrete,

and a plentiful supply of water should be available for cleansing purposes.

The floor of a **slaughter-house** should have a slight fall from all sides towards one point close to the wall, through which a pipe should be carried to a gully on the outside. The gully best suited for the purpose is one similar to that which is represented on p. 98, Fig. 41, which is provided with a bucket to allow of easy removal of any deposit.

The floor of a **cowshed** should have a slight fall towards a central shallow channel, which should have an inclination towards the outside wall, through which a pipe should pass to a gully in the manner just described.

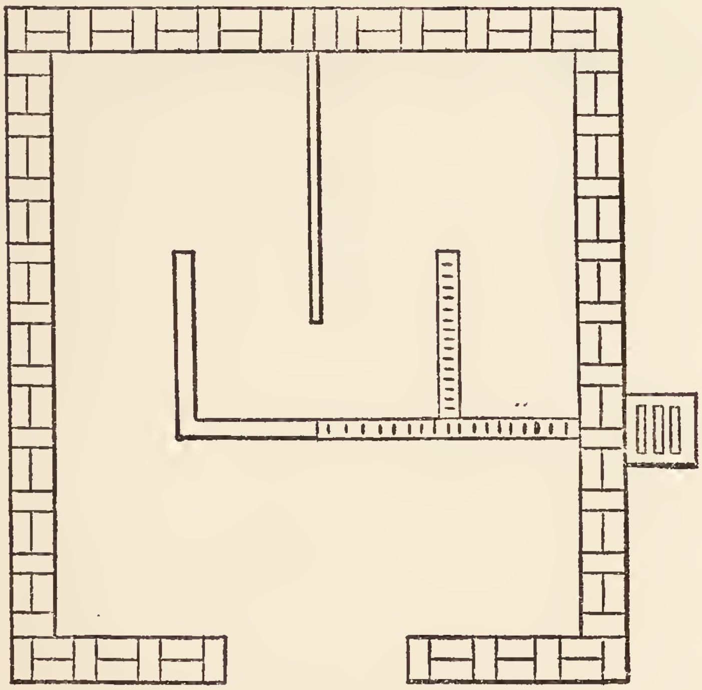


Fig. 66.

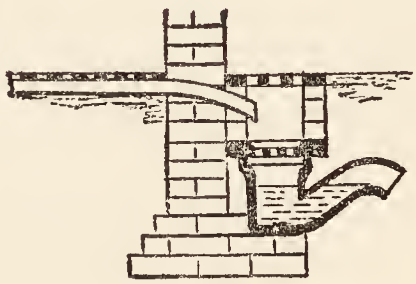


Fig. 67.

Stables should be drained in the same manner, except that the surface channels should be constructed of half-channel iron pipes, coated with a protective coating, such as Angus Smith's preparation, and covered with movable, perforated iron-plates, as is represented in the drawing (Fig. 66). These plates should be periodically removed for the purpose of washing out the channels. For the sake of appearances, the gully, in place of being fixed on a level with the surface of the ground, may in all these cases be sunk a little distance, so as to admit of the pipe which passes through the wall discharging underneath an additional grating placed above that which covers the gully, on brickwork laid in cement, in the manner shown in section in the drawing (Fig. 67), or a gully with side inlet may be used.

Piggeries, as they are usually constructed, give rise to great nuisance, but this may at least be considerably modified if the styes are properly built, and ordinary attention is paid to cleanliness. Wood is frequently used for the flooring, and it soon becomes saturated with decomposing filth. The floors should be properly paved with impervious bricks or asphalt, and although, in this case, the drain may be connected with a gully placed within the uncovered enclosure, it is more cleanly to make the connection in the manner described in the case of cowsheds, etc.

It is a common practice among pig-keepers to allow a large collection of manure to remain within the enclosure, so that it may be trodden by the pigs, with the object of adding to its virtue as a manure. This, besides creating a nuisance, must injure the health of the animals.

CHAPTER VI.

DETAILS OF PLUMBER'S WORK.

THE connection of the various sanitary appliances with the drains—that is, the plumbing work—has now to be considered, and it is here we meet with the most glaring defects. The appliances themselves may comply in every respect with the principles laid down already, and yet the useful purposes for which they have been designed may be entirely defeated through the ignorance or culpability of the workmen employed in fixing them. The public are greatly to blame for this. So long as plumbers are employed whether they can show any evidence that they possess a knowledge of their work or not, so long will scamped work be turned out, money wasted, and health endangered. The best way to correct this is to refuse to employ all uncertificated plumbers, and only engage those who possess recognised certificates. If there is one branch of work in which the maxim efficiency before economy is specially applicable, it is that of plumbing. *All cheap plumbing is bad, and good plumbing is worth paying for*

WATER-CLOSET CONNECTIONS.

The **soil-pipe,** as already stated, must be placed outside the house, and in a situation where it is screened, as far as possible, from the direct rays of the sun, so as to avoid its becoming bent from expansion; it ought not to be larger than 4 inches in diameter, and for the purpose of ventilation it should be carried upwards, full size, to above the eaves of the house, and terminate at a spot well removed from all windows or chimneys. It is by no means unusual in old houses to meet with soil-pipes 5 or even 6 inches in diameter, placed inside the house, and, if ventilated at all, only by an inch pipe terminating at a point where the foul gases it emits may enter rooms, or even contaminate water supplies. Examples of such arrangements will be given later.

The objection to a large soil-pipe is, that it presents a larger surface to be flushed, and a greater area on which deposit may

take place, in addition to the fact that it costs more. A 3-inch soil-pipe will really answer all requirements, the only objection to it being the greater risk of syphonage of traps, an accident, however, which may be guarded against; if several closets are connected with one soil-pipe it is safer to use a $3\frac{1}{2}$-inch pipe.

Drawn-lead soil-pipes are by far the best; **seamed lead pipes** are absolutely inadmissible, and **iron pipes** are not satisfactory, as the interior is not smooth, they corrode very readily, and unless they are strong enough to allow of the joints being caulked in with lead, a tight joint cannot be made. The only iron pipe that may be used is a water main or "underground" pipe (coated with Angus Smith's solution), as it is strong enough to allow of a caulked lead joint (see p. 127) being made. Another objection to iron soil-pipes is the difficulty of making a good joint between them and the lead junction or trap, and an iron trap must not be used.

The objection to a soldered seam-pipe is, that it may become faulty along the seam from corrosion having weakened the union, and from variations in temperature causing expansion and contraction of the pipe. An old seamed soil-pipe that is absolutely perfect is seldom met with, although if the workmanship is very good, such a pipe may last for a long time.

Drawn-lead pipes ought to be of uniform thickness throughout, and of at least 7 lbs., or, still better, 8 lbs. weight per superficial foot.

With regard to the **ventilator,** or air-pipe, which is simply a continuation upward of the soil-pipe, all bends in it should, as far as possible, be avoided, but when necessary to introduce an angle it ought to be an "easy" one. It is a very common practice to carry the ventilator round, in place of through the eaves of the roof, thereby greatly interfering with the current of air (see p. 55). If there should chance to be a window in the roof near to the point where the ventilator pierces the eaves, the pipe must be carried with an easy bend upwards along the roof to some distance above the window. It would be less unsightly, no doubt, not to pierce the eaves in this case but to carry the ventilating pipe through the wall and upwards inside the roof, bringing it out with an easy bend at the proper point, but this would not be a desirable arrangement.

Cowls are sometimes placed on the top of ventilating pipes to encourage an upward current of air. Except in wet weather it is a question whether anything is gained by their use, and there is a risk that birds will build in them. The same risk applies

when the ends of the pipes are left free, so it is advisable to cap them with wire netting of large mesh, fixed so that it projects upwards in a semi-spherical form.

Joints.—The best joint for a lead soil-pipe is a **wiped-joint** (Fig. 68), but, unfortunately, it is not by any means always met with, even in recent work. What is known as a **copper bit-joint** (Fig. 69) is the joy of the plumber, because it requires less skill to make; as regards strength, however, it will not compare with the wiped-joint.

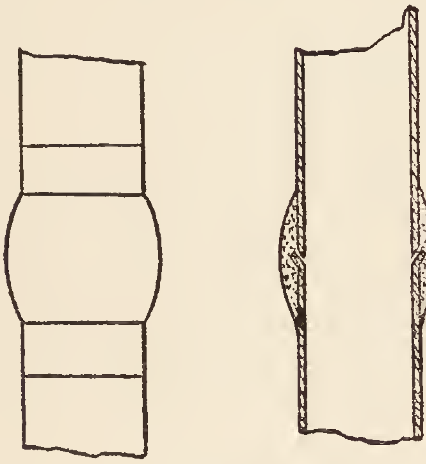


Fig. 68.

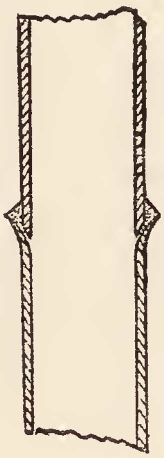


Fig. 69.

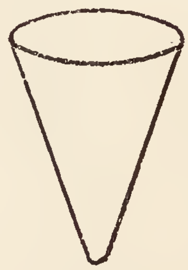


Fig. 70.

Wiped-joints are made as follows, whatever the size of the pipe may be :—First, what is called a "tan-pin," which is a pear-shaped block of box-wood (see Fig. 70), is introduced into the upper end of the lower length of pipe, and by means of a mallet it is hammered into the pipe, so as to produce a bulging of the edge to allow of the introduction of the lower end of the upper segment, which should also be bulged outwards by means of the tan-pin, but to a lesser extent. The two ends should then be rasped down on the outside, leaving only a thin edge on the entering pipe to allow of its adjusting itself to any slight inequality, and leave a space between the upper and lower segment into which the solder will run, thereby making the joint more perfect. The accompanying section (Fig. 71) illustrates what is meant. The proper distance for the upper pipe to enter the lower is from $\frac{1}{2}$ to $\frac{3}{4}$ inch. Having thus adjusted the ends so as to secure an accurate fit, the next proceeding is to apply a paint composed of lamp-black, glue, and whiting to the outside

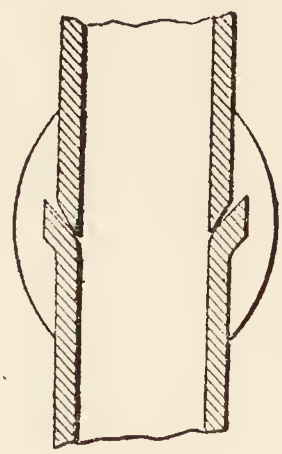


Fig. 71.

of the two abutting ends, for about 4 inches along the pipes in the case of a 4-inch pipe, and when this is dry the surface of each for a distance of 2 inches is "shaved" with a special hooked blade (shave-hook), care being taken not to remove more than the paint and the finest surface of lead. The object of this shaving process is to remove all the outer surface of the lead, so as to present a perfectly untarnished surface for contact with the solder, but the workman must be careful not to shave too deeply, otherwise the joint will be correspondingly weakened. This being completed, the shaven ends are immediately smeared over with grease (tallow) to prevent re-tarnishing of the surface, which would interfere with the adhesion of the solder.

Previous to the above preparations, the solder-pot, with the necessary quantity of solder, has been got ready for melting—a process which has to be carefully conducted, so as not to overheat the metal, in which case it would not afterwards admit of wiping. Plumbers usually ascertain when the proper temperature is reached by applying a piece of paper to the molten metal, and the moment the heat is sufficient to ignite it, the pot is removed from the fire.

The solder is now poured on to the accurately adjusted pipes, and wiped round into the shape represented in the drawing by means of a "soldering-cloth," which must be smeared with grease to prevent the solder from adhering to it. It is never necessary to use a soldering-iron in the case of small pipes, but if the joint has to be made in an upright 4-inch pipe, the soldering-iron will be required to heat the surface. The best material for a soldering-cloth is moleskin, four or more folds in thickness, but strong linen will answer the purpose. The solder that is used for making this joint consists of tin and lead, in the proportion of one of the former to two of the latter.

Copper-bit joints (Fig. 69), although far inferior to wiped-joints, are still frequently made, but no plumbing work of this description can be passed as other than third-rate. So far as the first part of the process is concerned, it is very similar to that in the case of the wiped-joint, except that the bulging outwards of the upper end of the lower pipe is carried farther. The solder is not melted in a pot, but is used in the form of a stick, and run into the space between the two pipes by means of a heated copper-iron (copper-bit), hence the name. In this case, the proportion of tin to lead, in place of being one to two, is one to one, that is, the two are in equal proportion, the reason for this being that in this proportion it retains its heat long

enough to enable it to float into the space. A glance at the drawings will indicate, without any further comment, how greatly superior the wiped-joint is as compared with the copper bit-joint.

What is called a **blown-joint** is made as follows:—Having prepared the pipes in the manner already described, they are adjusted; the abutting ends are then heated by means of a blow-pipe flame, for which purpose a candle is generally used, and when sufficiently hot, a stick of solder is applied, which is melted by the heated pipe and runs into the joint. This process is continued round the circumference of the joint until it is completely sealed. It is obvious that such a joint will bear very little strain, and it is only found in plumbing work of the worst description.

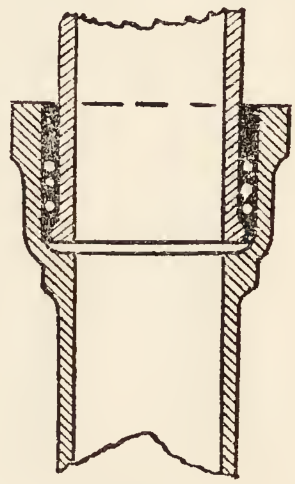


Fig. 72.

If **iron** is the material used for soil-pipes, the joints must be **caulked with lead,** and to allow of this, as already stated, the pipe must be stronger than the ordinary rain-pipe. The upper pipe is first adjusted into the socket of the lower, and then, in order to prevent the molten lead from running into the pipe, a few rings of spun yarn are well rammed down into the socket; the lead is now run in, and afterwards it is thoroughly caulked (see Fig. 72). The depth of lead forming the joint should not be less than 2 inches.

An excellent caulked lead joint may now be made without molten lead by using lead wool, which consists of strands of fine lead thread. These strands are pushed into the joint, and afterwards, by caulking in the usual way, the lead fibres or threads are consolidated together, and thus form a perfectly tight joint. There is no limit to the size of pipe which may thus be jointed with lead, and this method of jointing iron pipes is coming into general favour because of its simplicity.

It is by no means an uncommon practice, indeed, it may be said to be the usual practice, to make the joints of iron soil-pipes of putty or cement, but this ought never to be done. There are other good forms of joints, for example the **block** and **astragal,** each adapted for special circumstances—the former when the soil-pipe is let into a chasing in the wall, and the latter when the appearance of the wiped-joint is objected to; space, however, will not allow of a further detailed description; those that have been described are what are usually met with.

It is important that the soil-pipe should be fixed firmly on to the wall, and this is accomplished by means of "tacks," which are square plates of thick lead, measuring about 9 or 10 inches, soldered on to the back of the soil-pipe, and fixed to the walls by screws, to receive which wooden plugs have been let in. For a 4-inch soil-pipe, it is necessary to have three tacks for every 10 feet, although plumbers usually make two answer the purpose.

Fig. 73.

Lead pipes may be bent out of shape and dented in transit, and before being fixed they must be **straightened.** This is done by driving a "mandril" through the pipe. This is a round piece of wood about 2 feet in length, and of the same diameter as the interior of the pipe. While this mandril is being driven along by an assistant, the operator is engaged in hammering out the surface irregularities by means of a "dresser," which is a wooden implement of the shape represented in the sketch (Fig. 73).

Bends.—A good workman can bend a drawn-lead pipe, whatever its size may be, into any angle that may be necessary. To do so, however, requires skill, so as not to weaken the pipe, or alter its circular form. Having straightened the pipe, and removed all dents, in the manner already described, it must be heated at the point where the bend is desired to be made. This may be done in various ways, but the most usual is by applying molten lead to the exterior, having first coated it with the paint that is used in making wiped-joints, to prevent the molten lead from adhering firmly to the pipe. The next process is to forcibly bend the pipe to a limited extent, and as in doing so it becomes partly flattened at the bend, its circular shape has to be restored. This is done as follows:— While an assistant hammers the interior of the bend, by means

Fig. 74.

of a "dummy," which is an elliptical, flattened block of lead on a basis of iron, fixed at a slight angle to the end of a stick, with a handle at the other end (Fig. 74), the operator hammers the outside of the pipe on either side, the blows being directed towards the heel (that is the larger curve of the pipe) with a dresser.

This is continued until the circular form of the pipe is completely restored. The whole process is again repeated, until the necessary amount of bending has been accomplished.

It is obvious that in bending a pipe there is a tendency to diminish its thickness at the heel, but the process of dressing, if the bending is not carried too far at one time, will counteract this tendency.

Bends to suit various angles may be purchased, but their use necessitates extra joints, and for that reason it is far better to mould the pipe itself to the requisite angle, in the manner described.

In the case of pipes which are too small to admit of a dummy being introduced, the circular shape of the bend may be restored by using a series of " bobbins," which are oval-shaped blocks of wood with somewhat flattened ends (Fig. 75). A small-sized one is first introduced, followed by larger ones, and they are driven through the bend until its circular shape is restored.

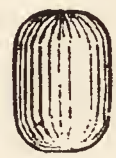


Fig. 75.

The **soil-pipe connection** is one of the most important of the water-closet fittings, especially since the introduction of the wash-down earthenware closets, between which and the lead soil-pipe it is difficult to make a permanently tight junction.

In the case of a wash-down closet fixed on the ground floor, it is a comparatively easy matter, as there is no necessity for a lead connection; the closet pipe may be connected with the drain itself. In such a case it is better that the joint should be above the floor, so that it may readily be seen, and in order that this may be managed, the downward curve of the **S** must stop short at the floor, so as to allow the socket of the drain-pipe to be brought up to it (Fig. 76). Such a joint ought to be made with good Portland cement, and in order that this may be done the end of the outlet-pipe from the closet (the spigot) is left free from glaze for about 2 or 3 inches. If it is intended to fix a closet of this description on an upper floor, it is better to select one, the outlet-pipe from which, in place of passing downwards to the floor, is directed backwards, as is represented by the dotted lines on Fig. 57, p. 109. In some cases the outgo is flanged, and the joint is made by screwing it tightly against a similar flange, which is formed by tafting back the abutting end of the lead connection, an india-rubber ring being interposed, as is represented in section by the drawing (Fig. 77).

The drawing (Fig. 78) represents one of Dent & Hellyer's

pedestal "Hygienic" closets, with a flanged outgo, as shown in the large section.

This, however, is not a good joint, as india-rubber is perishable, and it is by no means easy to hammer out a flange on the lead connection which will perfectly adjust itself to the flange of the

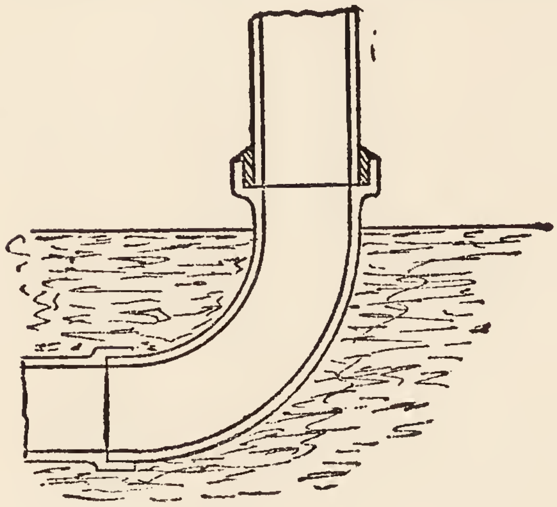


Fig. 76.

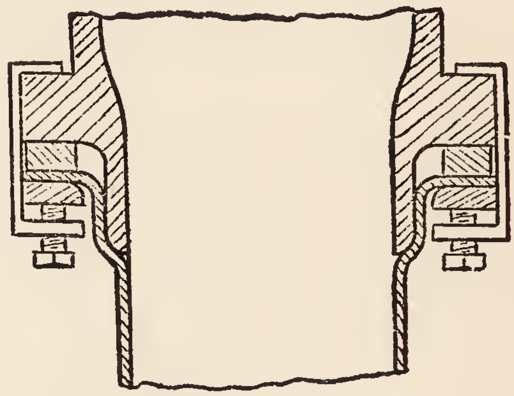


Fig. 77.

closet, and it is obvious that unless the adjustment is perfect, and the surface of the lead flange is smooth and uniform, tightness of the joint, which is entirely dependent upon the rubber washer, will not be attained.

Another joint may be made, which is better than that which

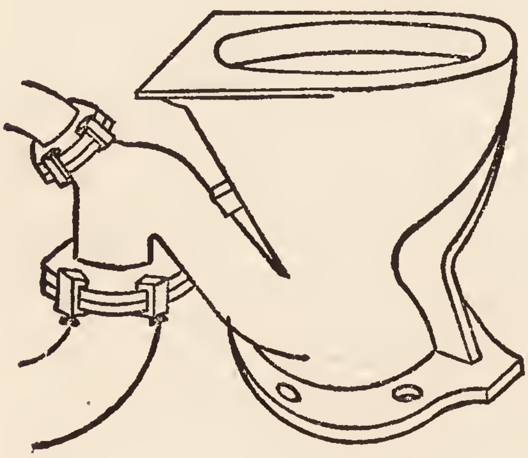


Fig. 78

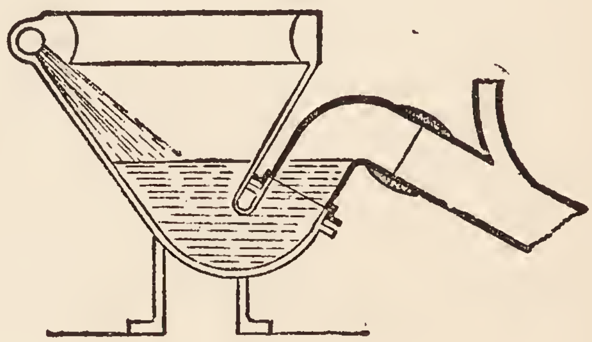


Fig. 79.

has just been described, provided a **lead-pipe outgo** is bolted on to the closet, for then the junction being between lead and lead, a thoroughly good wiped soldered joint can be made.

The drawing (Fig. 79) represents such an arrangement fixed to the "Vortex" closet of Dent & Hellyer. It will be noticed that the lead outgo is connected to the earthenware trap below

the level of the water, so that if any fault should occur, it will immediately be noticed, owing to leakage occurring.

An excellent joint, the *metallo-keramic*, has been brought out by Doulton, in which a portion of lead pipe is soldered on to the outgo of the closet by a special process, and thus the soil-pipe and anti-syphonage connections can be made by means of plumber's wiped joints. This patent joint adds to the cost of the closet, but it is well worth paying for. Other makers, Twyford for example, make a joint somewhat similar to the *metallo-keramic*, which also allows of a wiped joint connection being made. Possibly it may not be so neat in appearance as Doulton's joint, but still, it is to be preferred to any adjustable joint in which washers are necessary.

In fixing a **valve closet,** the opening into the trap, the fixing of which will presently be described, is smeared round with red lead, and the outgo pipe from the valve-box is introduced into it.

As already pointed out (p. 102), there is always a risk of traps of the **S** pattern becoming **unsealed by syphonage,** and to avoid this it is essential to fix an **air-pipe** close to the top of the outlet of the trap. All stoneware closets of the wash-down kind have now an opening provided for this purpose, and it is not unusual for ignorant workmen to suppose that this is intended for a soil-pipe ventilator, although it is only 2 inches in diameter. If one closet only is connected with the soil-pipe, it answers the purpose perfectly to carry this air-pipe from the top bend of the syphon upwards through the wall, and connect it with the soil-pipe ventilator, but if two or more closets are connected, a special ventilating-pipe must be carried up to above the highest closet, where it may then unite with the soil-pipe ventilator, having, on the way, received the various air-pipes from each closet trap. Lead is the best material for this, as for other air-pipes, and all the joints ought to be wiped. Here the difficulty again arises of making a tight joint between lead and earthenware, in the case of the wash-down closet, unless it has a lead outgo, or unless it has a flanged vent-arm, as is shown in Fig. 78. For this reason it is best to connect the air-pipe to the lead branch beyond its junction with the closet, and seal up any opening that may be provided for the purpose in the earthenware part of the apparatus—that is, with the above exception, when a rubber-ring joint may be made.

The **valve-box** of a valve closet ought also to be ventilated, but in this case, all that is necessary is to carry it through the wall direct, where it may be cut short. The chief object of this

ventilating pipe is to prevent syphonage of the trap connected with the pan overflow, which otherwise may occur, particularly when slop-water is thrown into the closet, and thus a large quantity of water is suddenly discharged.

The junction of the soil-pipe with the drain is not so simple a matter as many workmen seem to think, and it is often made in a very faulty manner. The usual practice is to introduce the plain end of the soil-pipe into the socket of the drain-pipe, the joint being made with cement in the ordinary way; this, however, is not a satisfactory method.

The drawing (Fig. 80) shows the proper method of making this joint. It will be noticed that a brass ferrule is soldered on to the end of the lead soil-pipe, having a flange fixed to it so as to rest on the floor of the socket of the drain-pipe, the brass union being

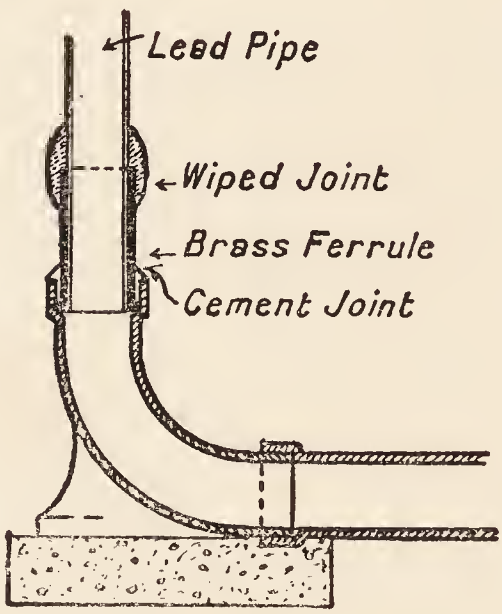


Fig. 80.

prolonged for about 2 inches below the flange thus projecting into the drain to that extent. The joint connecting the ferrule with the drain is made with cement in the ordinary way. A pedestal bend should be used for the drain connection to insure stability.

The **service-pipe** to the closet, which, as already pointed out, must on no account be connected direct with a cistern that supplies drinking water, or with a general service-pipe, ought to be of sufficient size to insure a flush. The diameter must never be less than $1\frac{1}{4}$ inches, and this is too small unless the flush-tank with which it is connected is fixed more than

5 feet above the rim of the closet. Any elevation under this requires a service-pipe of at least $1\frac{1}{2}$ inches to insure a good flush. The usual method of connecting the service-pipe with the closet-basin is by means of putty or red lead, but rubber caps are now made which answer the purpose well, and they last for a long time.

In the case of a valve closet which is provided with an **overflow** (see p. 105), frequently trouble arises owing to its being wrongly constructed.

All overflow-pipes, wherever they may come from, must be carefully followed up in investigating into the sanitary condition of a house, as it frequently happens that work, which would otherwise pass muster, has to be condemned because of faulty overflows. One method of dealing with the closet overflow is to connect it with the valve-box, as shown in Fig. 51, a syphon-trap being interposed in all cases. Another method is to carry it into the ventilator of the valve-box (see Fig. 82).

In case any leakage should occur, it is necessary to fix a **safe** under valve closets, and here again the overflow from the safe is often a source of danger, owing to errors in fixing. The safe itself should be made of lead (4 or 5 lbs to the superficial foot), the sides being formed by turning up the edges to a depth of about 4 inches, and soldering each angle

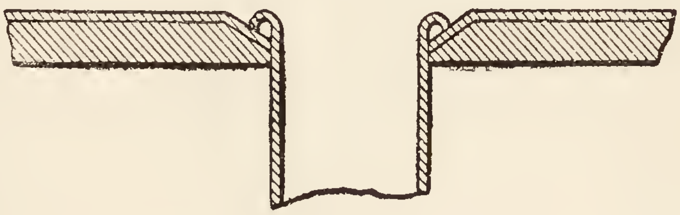
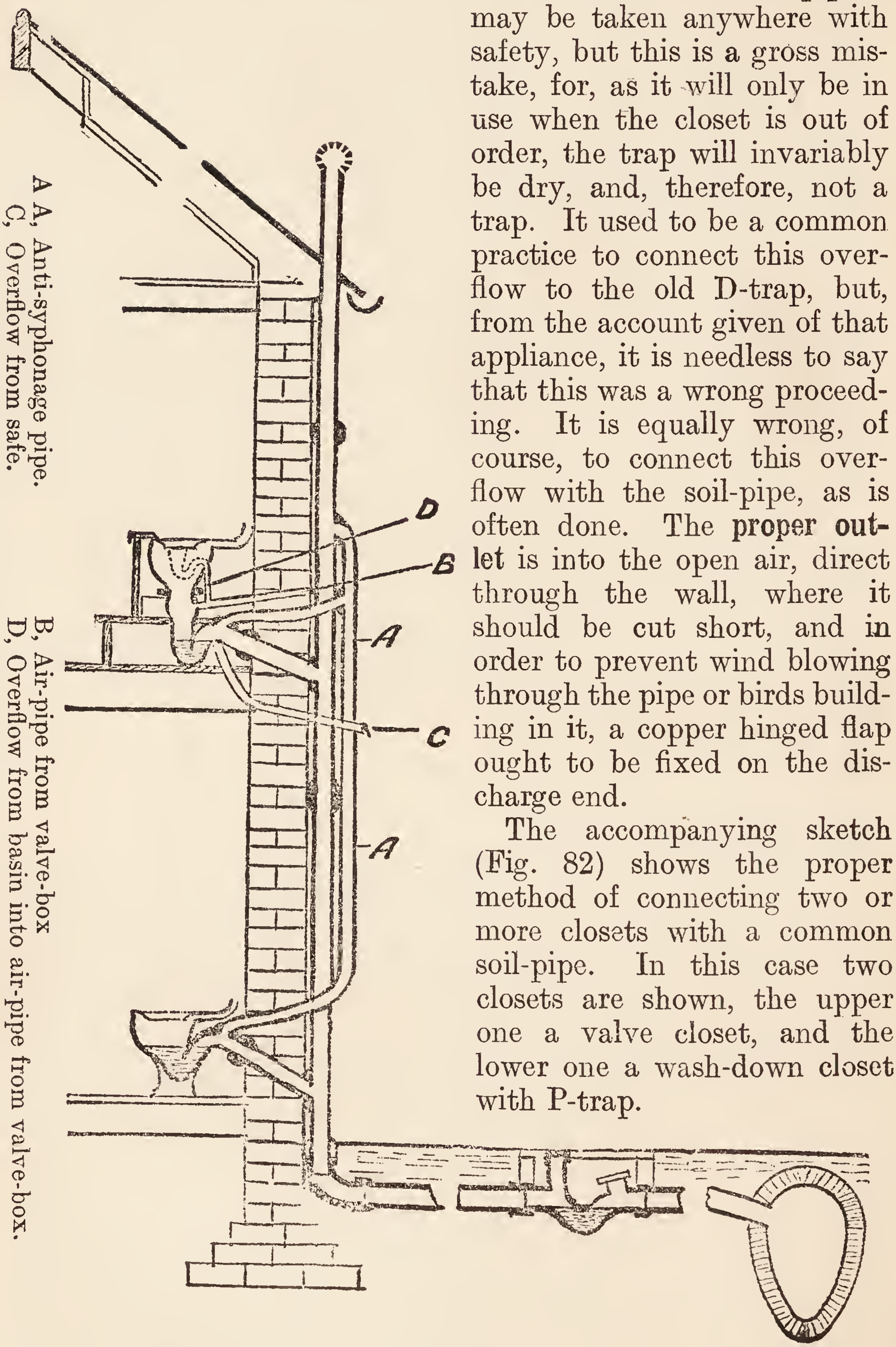


Fig. 81.

If the closet-trap is below the floor, which is generally the case, the edge of the opening in the floor of the safe, through which the outgo-pipe passes from the valve-box, ought to be carefully soldered to the trap in the manner represented in the sketch (Fig. 81). A bevelled opening is made in the floor, as shown in the drawing, the circular hole in the bottom of the safe tray being cut smaller to allow of the lead being tafted into the opening in the floor. The inlet to the trap is then tafted into a bead, so as to rest a little way down the opening, the space above, between the bead and the lead of the safe tray, being filled in with solder. In order that this safe may serve the purpose for which it is intended, it is necessary that its overflow pipe should be large enough to carry off all possible overflow water, should any accident happen to the closet. The $\frac{3}{4}$- or even 1-inch pipe that is usually fixed is useless for this purpose, the proper size is $1\frac{1}{2}$ or 2 inches. Plumbers

are apt to think that if a trap is fixed on this overflow-pipe it may be taken anywhere with safety, but this is a gross mistake, for, as it will only be in use when the closet is out of order, the trap will invariably be dry, and, therefore, not a trap. It used to be a common practice to connect this overflow to the old D-trap, but, from the account given of that appliance, it is needless to say that this was a wrong proceeding. It is equally wrong, of course, to connect this overflow with the soil-pipe, as is often done. The **proper outlet** is into the open air, direct through the wall, where it should be cut short, and in order to prevent wind blowing through the pipe or birds building in it, a copper hinged flap ought to be fixed on the discharge end.

The accompanying sketch (Fig. 82) shows the proper method of connecting two or more closets with a common soil-pipe. In this case two closets are shown, the upper one a valve closet, and the lower one a wash-down closet with P-trap.



A A, Anti-syphonage pipe. B, Air-pipe from valve-box
C, Overflow from safe. D, Overflow from basin into air-pipe from valve-box.
Note.—As regards the anti-syphonage pipes, see footnote to Fig. 51, p. 105.

Fig. 82.

So much for water-closet connections; we will consider later the more usual faults met with, some of which have already been alluded to.

Sink Connections.

Sinks may be lined with lead or tinned copper, or they may be constructed of pottery ware. The last are the most cleanly, but they are very destructive of glass, which is very likely to chip against the hard surface unless greater care is observed than servants usually exercise. Copper has a more cleanly appearance than lead, and it is more durable. It is a mistake to economise in the thickness of the metal used, as so little is required that the difference in cost between 8 lb. and 6 lb. lead, for example, is not worth any consideration, and is more than balanced by the saving in repairs.

It is a common mistake to suppose that the waste-pipes from sinks need not be trapped inside the house provided they are cut off over a gully-trap outside. All such pipes should have a syphon-trap fixed immediately under the grid, with a screw cap at the lower end for cleaning purposes (see p. 100). They should be fixed at one corner of the sink, at the back, and the bottom of the sink should have a slight slope in that direction, so as to insure that all water may drain away. The waste-pipe at the junction of the sink ought to expand—that is, it ought to be funnel-shaped, with a diameter at least an inch larger than the rest of the pipe, so as to allow of a grating being fixed without diminishing the possible discharge. This grating should be sunk in a cup below the bottom of the sink, which is fitted with a plug attached to a chain. This plug is useful for flushing purposes, as the sink may thus be periodically filled with water, which is allowed to discharge with full force through the waste-pipe. An overflow-pipe large enough to carry off the amount of water that may be delivered from the service-pipe, should it accidentally be left running while the waste may be closed, ought also to be fixed near the top, and either carried through the wall or connected with the waste above the syphon-trap.

For sinks on the ground floor, the waste-pipe and syphon-trap may be $1\frac{1}{2}$ inch throughout, but in the case of draw-off sinks on upper floors, it is advisable to use a $1\frac{1}{4}$-inch "anti-D-trap" for a $1\frac{1}{2}$-inch waste, as a precaution against syphonage, and in such a case, as an additional security, the waste-pipe may be continued upwards as a ventilator, with which an air-pipe from the top of

the syphon must be connected, as described under soil-pipe ventilation (see p. 131)

Slop-sinks.

In most houses the water-closet is used as a slop-sink, and with ordinary care on the part of servants, there is no r ason why it should not be used, although it is hardly possible to insure this. If the seat is hinged, and the servant will take the trouble to lift it and empty the slop-pail into the pan itself, no nuisance need arise, especially if the closet-pan is specially designed for the purpose, as some are, by having a broad margin or " table top " as it is termed, the surface of which falls in all directions towards the basin for splashings to drain into it.

Special slop-sinks, however, are now frequently fixed. They consist of a basin, either of cast iron enamelled inside with white porcelain enamel, or, better still, of earthenware, and the connections in all respects resemble those of a wash-down closet, except that the waste-pipe need not be larger than from 2 to 2½ inches.

On account of the great danger of syphonage from the momentum of water that is usually discharged in this case, it is most essential to ventilate waste-pipes, and to connect the top of the syphon with the ventilator by means of an air-pipe the full diameter of the pipe itself. To avoid the risk of soap, scouring-cloths, etc., entering the waste-pipe, it ought to be protected by cross bars of brass.

All slop-sinks ought to be provided with a water-flush similar to that of a water-closet, and each time the sink is used it ought to be flushed, otherwise it is certain to become foul.

Urinals.

It is well, as far as possible, to avoid fixing urinals within houses, but, whether inside or outside, nuisance will arise from them unless an ample water-flush is provided. It is important also that all parts of the apparatus with which the urine comes in contact, should be exposed to the flush, otherwise fungoid growth will soon occur.

This flush must be brought into operation automatically by syphonic action, and the water tap should be so adjusted that the flush comes into operation at short intervals. The treadle flush at one time adopted is now discarded because of the fouling of the mechanism which is liable to occur.

The disgusting nuisance that arises from a badly flushed urinal is too well known to require description; it is always present in the case of slate-back urinals without basins, so common in railway stations, although great improvements in these appliances are gradually being effected in the larger stations. Many excellent contrivances have been designed by various firms for limiting the nuisance arising from urinals, but space will not allow of a description of them; suffice it to say that, given a good supply of water, and a free hand as regards expenditure, no difficulty need be experienced in abolishing all the evils associated with them: at the same time no amount of freedom with regard to the latter requisite will compensate for an absence of the former. In other words, without a plentiful use of water, all appliances are unavailing.

It is unnecessary to say that all urine basins joining a common waste ought to have separate syphon-traps, properly ventilated, and that the waste-pipe should not be directly connected with a drain, but discharge into a gully or other suitable trap. Also, the walls, and more especially the floors, must be non-porous; wood floors are quite inadmissible.

Baths.

As baths are frequently fixed in dressing-rooms, it is of the utmost importance that their wastes should be completely disconnected from the drains. This is done in the manner recommended in the case of sinks—that is, by a syphon-trap being fixed to the waste-pipe immediately beyond the discharge valve-box, the pipe then passing through the wall to join the waste-pipe, which may be common to other baths or lavatories, and which must discharge below on to a suitable trap, and be continued as a ventilator of full bore upwards to above the roof. The air-pipe, to prevent syphonage, must never be omitted; it should be of the same diameter as the junction waste-pipe, from which it should pass, from a point immediately beyond the trap to the air-pipe of the main waste, provided there are no other connections above. The best trap to use is the "**anti-D,**" * $1\frac{1}{4}$ inches, for ordinary houses, the branch pipe being $1\frac{1}{2}$ inches, and the main waste pipe 2 inches.

The overflow-pipe must be carried through the wall, where it should be cut short, the usual hinged copper flap being fixed on the end to prevent the air from blowing up the pipe. As a

* Hellyer.

protection against possible accident, a safe may be fixed under the bath, which must be similarly treated, or rather one may be made to answer both purposes, by the overflow-pipe from the bath being carried to the mouth of the waste-pipe from the safe.

Lavatories.

Precisely the same precautions must be observed in fixing lavatories as have been described in the case of baths, and the same waste-pipe may answer for both, provided it happens to be conveniently placed. If more than one lavatory basin should be connected with one waste-pipe, it is necessary that each should be separately trapped, and each trap ought to be provided with an air-pipe to prevent syphonage, as is shown in the sketch (Fig. 83).

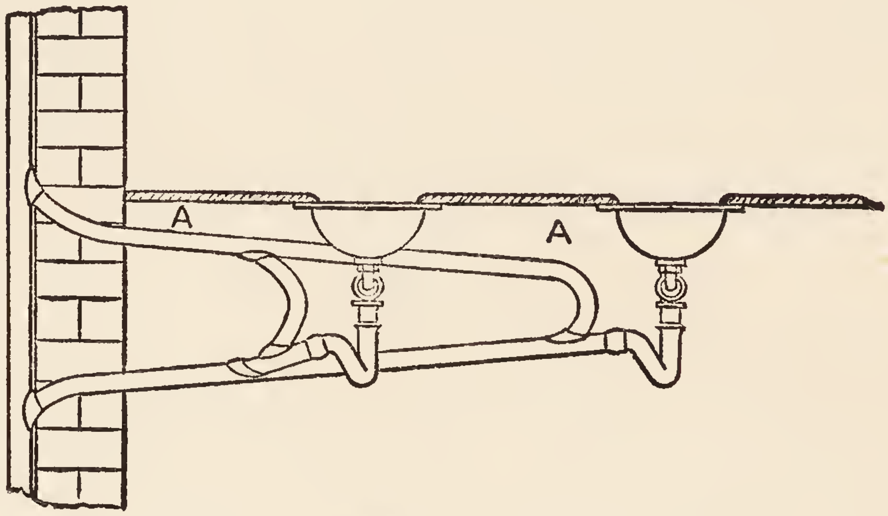


Fig. 83.

In the event of the waste-pipe being common to other lavatories or baths on upper floors, the air-pipe, A, A, ought not to be connected, as is shown in the sketch, but it should be carried to above the highest junction, for reasons already explained in the case of soil-pipes (p. 131).

Cisterns.

The materials of which storage cisterns should be made, as well as the position in which they should be placed, when their provision is necessary by reason of the water-supply being an intermittent one, have already been discussed, and the importance of not taking the service pipe to a closet (slop-sink, urinal, etc.), direct from the storage cistern, has also been pointed out (p. 24).

It now remains to consider how **cistern overflows** must be dealt with. It is essential that all cisterns, large or small, should be provided with overflow-pipes, otherwise, in the event of the ball-valve which regulates the supply of water to them getting out of order, great damage may be done to ceilings, walls, and floors. Faults of the gravest description are often met with in connection with cistern overflows. They are often directly connected in the most reckless manner with soil-pipes, drains, and foul traps, so that every facility is offered for contamination of water-supply, and if the plumber in his wisdom interposes a trap in the course of the overflow, he fondly imagines that all is safe, forgetting that the only occasions on which such trap can be replenished with water is when the cistern actually does overflow, an occurrence which never takes place so long as the fittings are in order. The only safe way of dealing with these as with all overflows, is to carry the pipe (which ought to be large enough to carry off the greatest possible intake of water) straight through the wall, where it should be cut short, a copper hinged valve being fixed on the end, for reasons already mentioned. By such an arrangement, the worst that can happen is the temporary discharge of a stream of water on to the pavement or yard below, and this may at once be stopped by turning off the water by means of a tap which ought always to be fixed on the cistern service-pipe, until such time as the fault may be repaired.

It may here be mentioned that, as a precaution against frost, all water-pipes outside the house should be laid well below the surface, and, as regards pipes within the house, the following instructions laid down by Mr. Hellyer ought to be observed :—"No service-pipe should be fixed on the external nor on the internal face of an external wall, especially a wall facing the north or east, without being cased-in and thoroughly protected. When possible, service-pipes should be fixed on the cross-walls inside the house, and never on the main walls, for the cold penetrates through the external walls, and reaching any pipe fixed on its face, though inside the house, freezes the water in it. If a pipe **must** come down on the internal face of a main wall, then an inch board should be put between the pipe and the wall, and the pipe cased-up, and the casing filled with cocoa-nut fibre. All service-pipes in roofs should be boxed-in, and the boxes filled with this fibre. . . . Where the service-pipe could not be boxed or cased-in, and where the cold air could reach it—as *e.g.*, under water-closet seats, where the pipe has to

leave the casing to reach the supply-valve of the water-closet—the pipe should be bound round with two or three thicknesses of gaskin, and then be covered over with canvas, to protect it from frost; the cold air coming in through the overflow-pipe of the safe, and blowing upon an unprotected pipe, would soon freeze it."

Examples of Insanitary Plumbing.

Volumes might be written concerning defective plumbing work, it is only possible here to call attention to these defects most commonly met with. From what has already been said, the reader will have gathered in what direction he has to look for them, but, as a preliminary to such an enquiry, it is well to point out that, in investigating the condition of the drainage of any house or premises, nothing must be taken for granted, the enquirer must satisfy himself regarding each detail by personal observation. However likely it may appear that things are as they seem, or as they are reported to be, it is possible that they are not, and much money may be wasted, and extra expenditure incurred, by a too hasty conclusion being formed on evidence that is only presumptive. Owners of property often complain, and justly so, that notwithstanding extensive alterations carried out, it may be, on the advice of an expert, former nuisances continue as bad, or even worse than before. Too often this is to be attributed to ignorance on the part of the adviser, but it also frequently results from a careless investigation in the first instance. It is a golden maxim, therefore, in all such enquiries, to avoid forming conclusions except upon fully ascertained facts.

The following authentic history well illustrates the importance of what has just been stated. In a modern house, under which the main drain passed to join the sewer, constant foul smells were experienced, and a considerable area of the wall, at the point of exit of the drain, was found to be damp. On the drain being exposed, it was found that leakage had occurred at various points in its course under the basement-floor, and a deposit had taken place which almost completely obstructed the passage of sewage. The remedy which was adopted consisted in relaying the pipes in concrete, with cement joints, a ventilator being fixed at both ends. For a time all appeared right, but it was noticed that the damp condition of the wall, in place of improving, became worse, and, as no other cause could be discovered,

the ground was re-opened at the point where the drain passed out, when, what ought to have been found out at first was discovered, namely, that the pipes were not continuous through the wall, but stopped short on either side, the intervening portion being formed by the hole which had been driven through the brickwork. At the first inspection this disgraceful piece of work was overlooked, as the pipes where they joined the wall on both sides had been carefully cemented all round. Possibly in this case it would have been better, in place of relaying the earthenware pipes, to have substituted iron pipes with caulked lead joints, but what was done would have answered the purpose had the want of continuity of the pipes been discovered by a more thorough examination in the first instance.

The following are a few examples of bad workmanship met with in the author's experience :—

In a large country house, which had been what was termed "thoroughly overhauled" about nine years previously (although the only trace of new work that could be found was the disconnection of the various sinks and rain-pipes over gully-traps), the following, among many other defects, were found :—

In the first place, all the drainage of the establishment, including stables, pig-styes, etc., discharged into a large cesspool, capable of holding about 10,000 gallons, situated in the stable-yard, within 20 feet of the house; adjoining this was a large soft-water tank, the overflow from which discharged direct into the overflow drain from the cesspool. At various points in the course of the drains, which were 9 inches in diameter, miniature cesspools, in the shape of dipstone traps, were constructed, and in the midst of these, within 30 feet of the large cesspool, the well which supplied the drinking water of the household was situated. The pipes leading to the cesspool were jointed with cement, but the drain which carried the effluent on to an adjoining field, was constructed of ordinary agricultural drain-pipes, without joints. As the well (which was very deep) and the cesspool were built of pervious brickwork, and as the subsoil was gravel, it is needless to say that, on analysis, the water proved to be little other than dilute sewage, although, under favourable circumstances, the quality would have been good. So much for the external arrangements. Within the house, every conceivable description of bad plumbing was to be found. In one wing, where the water-closets were fixed, one above the other, the service-pipes were carried direct from a large cistern under the roof, which was filled by a force-pump

from the well, and from which the drinking water also was drawn. The overflow-pipe, B, from the cistern was connected with the soil-pipe, which was of seamed lead, 5 inches in diameter. The soil-pipe was placed within the house; it was unventilated, and it leaked at various points along the seam. The highly objectionable pan closet, with D-trap, was fixed in each case, and the junctions with the soil-pipe were at right angles, and nearly on a dead level, the result being that each contained a filthy deposit. The overflow-pipes from the safes, E, which in this case had plenty of work to do, owing to the faulty condition of the closets, joined the soil-pipe junctions beyond the closet-traps, and so acted as ventilators connecting the soil-pipe and drains direct with the house. The soil-pipe joined a 9-inch drain, C, connected with a dipstone-trap, D. It is needless to remark that, apart from construction, the plumbing work itself was of the worst description. The accompany-

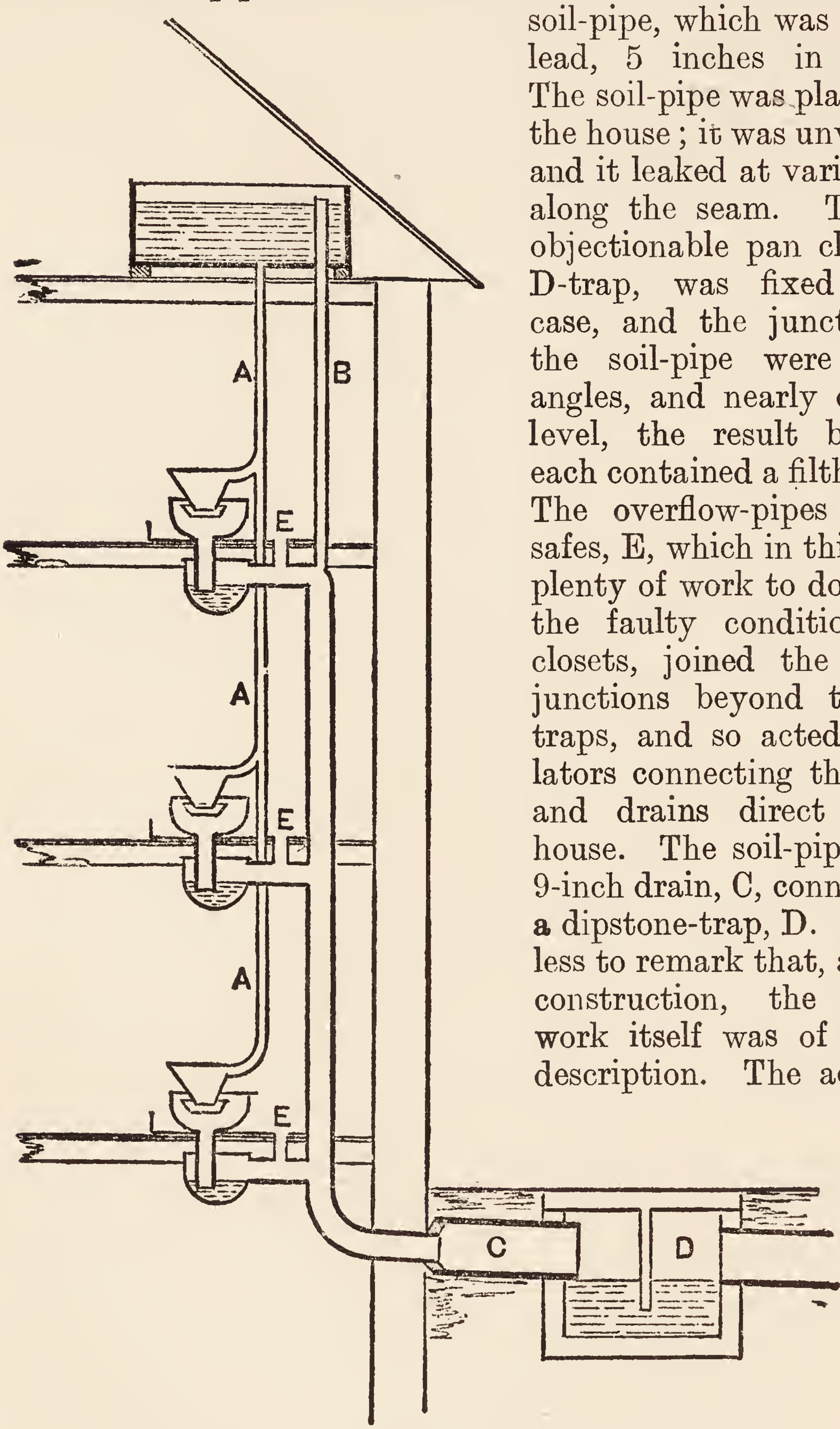


Fig. 84.

ing sketch (Fig. 84) represents the closet connections as described

above, but it by no means conveys an idea of the filthy conditions which were displayed when each part was exposed to view.

The following illustration (Fig. 85) is an example of work carried out, not very long ago, in a large house by a plumber who was told by the confiding owner to put everything in thorough sanitary repair. It illustrates, in a manner which would be amusing were

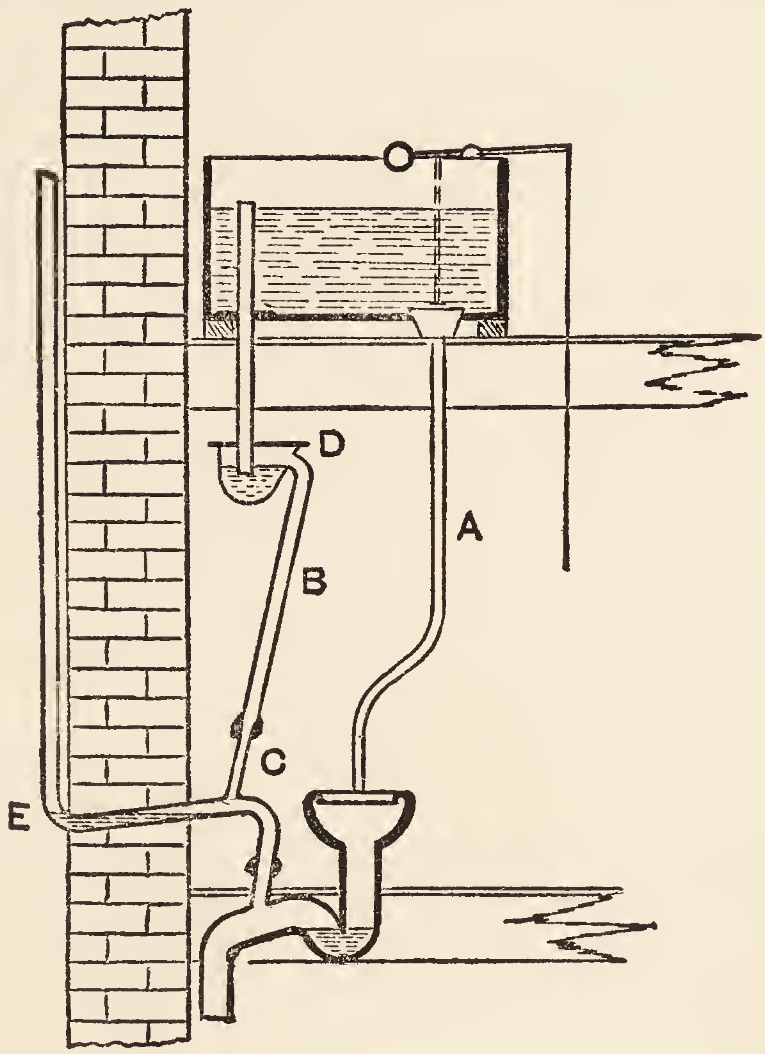


Fig. 85.

A, Drinking-water cistern supplying closet direct.
B, Overflow from cistern joining ventilator (?) to soil pipe.
C, Overflow narrowed by smaller pipe introduced.
D, Old D-trap.
E, Ventilating pipe passing out with downward bend.

the consequences not so serious, the crude notions that prevail among ignorant workmen.

In this case, a modern valve closet had, very properly, been substituted for an old pan closet, and a syphon-trap, with a proper air-inlet, was fixed in the drain before its junction with the sewer; the other connections, however, were left in

their original state, with the exception that an air-pipe $1\frac{1}{2}$ inches in diameter was carried from the top of the soil-pipe, through the wall, against the face of which it terminated about 8 feet above. This air-pipe at its junction with the soil-pipe was curtailed to $1\frac{1}{4}$ inches by a short piece of pipe, and before its exit it received the overflow from the large service-cistern above. Of course, the effect of such an arrangement for ventilation would be practically *nil*, and, as a matter of fact, it was absolutely so, for, in passing through the wall, the pipe took a downward in place of an upward course, thus forming a bend, which at the time of inspection was full of water discharged from the cistern overflow. Had it been the intention of the plumber to trap the air-pipe, to prevent the possibility of air passing along it, he could not have succeeded better, as there was no doubt about the water being permanently there, because the cistern was filled by means of a force-pump from the well, and must, therefore, have constantly reached the level of the overflow-pipe. The cistern overflow-pipe was $1\frac{1}{2}$ inches in diameter, but it also, before joining the soil-pipe ventilator, was curtailed to $1\frac{1}{4}$ inches, and in its course within the wall an old D-trap was fixed.

This by no means exhausts all the faults found in connection with this water-closet, for, on exposing the drain between the house and the syphon-trap referred to above, it was found to consist of odd pipes, 4 inches and 6 inches in diameter, united indiscriminately along its course, some of them even without sockets, and those that had having clay-joints, the result being that, notwithstanding a good fall, the drain was more than half full of deposit. One would have thought that, before fixing the intercepting trap a few years previously, the condition of the drain would have been ascertained; but experience teaches us not to marvel that no such investigation was made, and the probability is that had it taken place, little good would have resulted. Gross mistakes are often made in the drainage of houses by persons who possess only a superficial knowledge of the subject, and who, without understanding the principles, endeavour to improve upon the established practice as laid down by able sanitary engineers. The sketch (Fig. 86) is descriptive of what was met with in a house recently built, according to the plans, and under the superintendence, of an architect. As is usual in such cases, it was supposed by the owner of the house that, being a modern building, all the sanitary arrangements must necessarily be perfect, and on the occurrence of diphtheria in the house, the suggestion that the drainage might be at fault

was ridiculed by him. The following among other faults were found:—Immediately under one of the windows the closet-pipe, B, together with an untrapped lavatory waste, A, discharged into the open end of a 4-inch pipe, C, connected with the drain below; about 10 or 15 feet off was a syphon-trap, and the drain, for a distance of 2 or 3 feet on the house side of the trap, was freely open to the surface, except for a perforated iron grating.

There was not much fault to be found with the construction of the drain, the trap was properly placed, and it was right that the air-inlet should be where it was, although its continuation

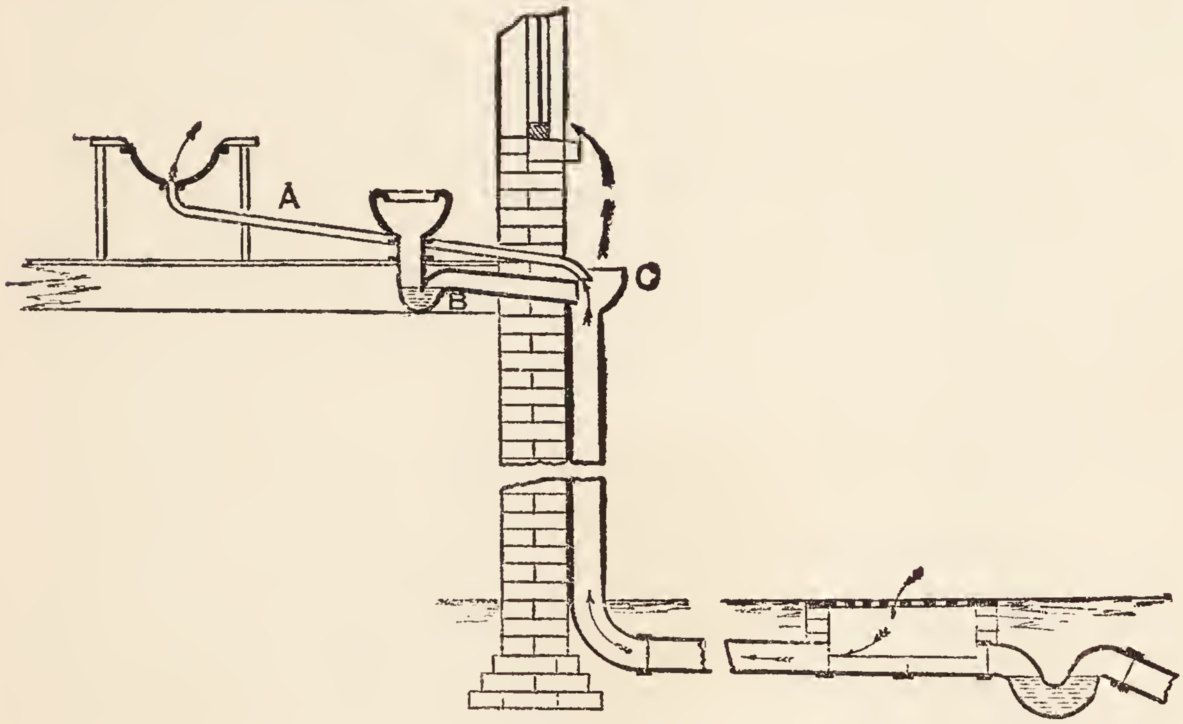


Fig. 86.

along the drain was unnecessary. On lifting the grating, however, a solid filthy deposit was found, extending along the bottom of the channel as far as could be seen. Also, on inspecting the soil-pipe at its open top, it was found to be thickly coated with a solid mass of fæcal matter, the stench from which was most offensive. Here the fatal mistake was made of overdoing the disconnection of the waste-pipes, and thus, to a large extent, losing the benefit of the flush, and exposing a needlessly foul soil-pipe and drain at a point immediately under the windows. In addition to this, and what was far worse, the untrapped lavatory waste-pipe conducted the foul effluvia issuing from the top of the soil-pipe direct into the house. The deposit in the drain no doubt was caused as follows:—Each time the water-closet was

used, a certain portion of fæcal matter was splashed against the expanded top of the open soil-pipe, C, where it adhered, and formed a rough surface, on which further deposit formed with each use of the closet, until in time projecting portions were detached and carried down to the drain by a flush, which, by reason of its being interrupted, was not sufficient to carry the solid matter onwards. In this way things went from bad to worse, until the drain practically became an elongated cesspool, ventilated into the house through the lavatory waste-pipe.

Drain-Ventilators.—As already pointed out, it is very desirable that all dumb ends of drains should be ventilated. The following sketch (Fig. 87) illustrates the importance of using lead in place of iron pipes for the purpose, owing to the tendency to corrosion in the case of the latter metal.

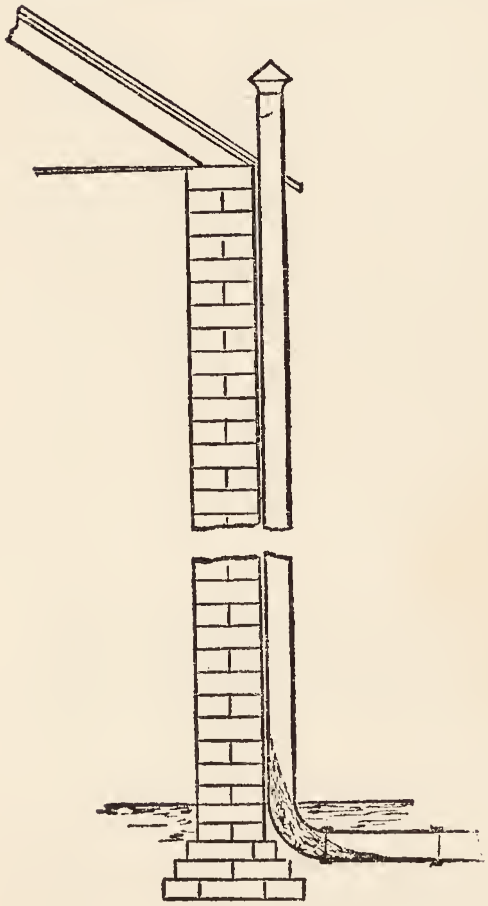


Fig. 87.

In the house in question, the architect had been most lavish in the provision of ventilating-pipes, but, although they presented an imposing appearance, and apparently provided for a very free circulation of air in the drains, when they came to be inspected, it was found that, with one exception, namely, that which was connected with the soil-pipe, they might all have been solid wooden dummies, so far as ventilation was concerned. The reason of this is apparent from the sketch; a solid deposit of iron rust, which had formed within the pipe, had gradually scaled off, and falling down, collected at the angle of the pipe, where it emerged from the ground, and formed a compact mass several inches in depth. The reason why the same had not happened in the case of the soil-pipe ventilator, was that the water-flush carried the rust off as it collected; from this, however, it must not be supposed that iron soil-pipes are desirable (see p. 124).

It is a common though a bad practice to make use of existing rain-water pipes as soil-pipe and drain ventilators, thereby liberating drain-air immediately under attic windows, and pro-

bably from pervious joints in the pipe as it passes the lower room windows. In addition to this, during rain, when upward ventilation is most needed, the down-flow of water converts these pipes into down-cast ventilators (illegal under P.H.A. Amd. Act, 1907).

Space will not allow of other examples of bad work being given, although in recent as in old work they are innumerable; probably enough has been said in this and the preceding chapters to indicate the faults that are commonly met with.*

Inspection of House Drainage.

Inspections into the drainage arrangements of houses ought invariably to be conducted systematically, according to a fixed plan. It is convenient to start in the cellar and work upwards, completing each floor in its turn until the roof is reached, and while keeping in view the conditions that are likely to be met with, they must not be allowed to bias one's mind, for thus fatal mistakes, which might easily be avoided, are often made; in fact, where proof is possible, take nothing for granted, and believe no one. It sometimes happens that a plan of the drainage exists, but, while this may assist one very much, it does not follow that it is accurate, so that it also has to be verified.

In the cellar any offensive smell must be noticed, and a careful search must be made for any drain connection, all barrels, boxes, etc., being moved, so that no portion of the floor may escape notice. If there is such a connection, the kind of trap (if any) and whether it contains water must be noted. In the absence of any drain connection, a pit is often provided in the cellar for the convenience of washing the floor, which, if of moderate size, is admissible, but usually it is large and contains foul deposit. A leaking drain under the floor may be suspected if the bricks are damp in circumscribed patches.

On the basement-floor, or on the ground-floor, if there is no basement, the sink connections will next be inspected. It must be noted whether the waste-pipe is trapped within the house, either properly so by a syphon, or improperly by the objectionable bell-trap, for example, and also whether it communicates with the drain direct or by discharging on to an outside gully. If the soil-pipe is within the house, it will probably be found incased

* For many interesting examples of bad work see *Defects in Plumbing and Drainage Work*, by Francis Vacher. *Dangers to Health*, by T. Pridgin Teale. *Disease and Defective House Sanitation*, by W. H. Corfield.

in wood within some wall, or in an angle formed by two walls, if it is not actually concealed by the plaster; possibly it may be placed within a pantry or larder. All coverings must be removed to enable the inspection to be made of the joints, seams, and substance of the pipe itself; damp brickwork or plaster will point to the existence of flaws if they are not apparent in themselves. If there should be a water-closet or lavatory on this floor, both should be thoroughly inspected, but probably neither will be found, as servants' closets are usually placed in a detached building.

On the first floor all water-closets, baths, lavatories, and sinks must be overhauled in detail. Any casing of wood that may surround the closet must be removed, so as to expose the soil-pipe connection, and the safe, if there is one, and the waste-pipe from the latter must be traced; in fact, the investigation must be conducted in view of the requirements of the special class of closet, as already laid down. The water-flush should be tested, if it is a wash-out or wash-down closet, by placing several pieces of paper in the pan, and noticing whether they are carried clear of the trap, and while this is being done, the operator should ascertain whether any smell can be detected. The air-pipe from the top of the trap must be looked for, and if it be a valve closet, its overflow must be traced, as well as the air-pipe from the valve-box. The inspector must be careful to notice whether the supply-pipe is properly cut off from direct communication with the house cistern, should such exit, as will be the case if the water-supply is not a constant one, or if the house is dependent upon a private well for its supply. All pan closets ought to be condemned, however they are fixed. If the soil-pipe should be within the house, and there are other closets on the floor above, it must be inspected as already described. If there is a bath-room on this floor, attention must be directed to the waste-pipe, to ascertain whether it is properly trapped under the bath, and disconnected outside from the drain, or whether it improperly discharges, either into the soil-pipe, or directly into the drain. Should there be a safe under the bath, its waste-pipe must be traced, remembering that it should be carried through the wall, where it ought to terminate; the overflow also, which should be similarly treated, must not be overlooked.

Lavatory wastes are often most carelessly dealt with. Not infrequently they are untrapped, and discharge into a soil-pipe or drain; but whether trapped or not, such connections are highly objectionable, and if met with, must be condemned. It

must be remembered that traps in general are all very well, but no trap will excuse an otherwise bad connection.

The same remarks apply equally to sinks. In old houses it will very often be found that the sink is placed on solid brickwork, through which its waste passes to the drain, which is thus directly connected with the house, except for the feeble protection offered by a bell-trap. Under these circumstances, the brickwork is saturated with filth, and in a great many instances the bell part of the trap will be found to be absent, thus allowing of the freest entry of sewer gas into the house.

The enquiry as regards the upper floor of the house must be conducted on the same lines, all drain connections, whether from water-closets, baths, sinks, or lavatories, being carefully inspected.

The inspector's attention must be directed to the various cisterns within the house, either for drinking-water or for rain-water storage. Their condition with regard to cleanliness; their overflows, whether improperly connected with a soil-pipe or drain, or properly discharging into the open, or, in the case of a rain-water cistern, on to a gully-trap outside the house, must invariably be noticed, and, as regards the overflows of cisterns fed by ball-taps, it must be remembered that traps afford no protection against bad connections, as they will not contain water. The possibility that cisterns may be found under floors must not be overlooked.

Having completed the examination inside the house, the outside drains or cesspools, closets, or privies, and the provision for refuse storage, must be inspected.

The true state of the drains cannot be ascertained except by the tests which are described later, but all traps that are accessible, and none ought to exist that are not, should be examined to see that they are structurally in accordance with sanitary principles, and are kept properly cleansed. The provision for drain-ventilation in the shape of air-inlets and outlet-shafts, and the position of the latter with regard to windows, their size, the soundness of their joints, etc., must be noticed. It may be found that the rain-pipes are made use of as soil-pipe or drain-ventilators, or that they are not properly disconnected over gully-traps. If underground rain-water tanks exist, their condition as regards cleanliness should be noticed, and their overflows ought invariably to be traced.

As regards receptacles for filth, privy-middens, ashpits, and cesspools, it should be ascertained whether they are so constructed as to be impervious, and, in the absence of a public

water-supply, their position with regard to the well must be considered.

Drain Testing.—It is not possible to assert positively that the drainage of a house is satisfactory from a mere surface inspection, particularly if the drains and their connections are within the house. The aim of all sanitary experts is to avoid laying drains under houses, and to carry each connection by as direct a route as possible through an external wall, all joints being placed where they can easily be inspected. Under such circumstances, it is easy to detect defective work in the case of new houses, but however thoroughly old houses may have been overhauled and their defects corrected, one never can tell that some disused drain may not have been allowed to remain concealed from view, although none the less dangerous on that account. The only means of ascertaining with certainty whether all is right, is by applying one or other of the approved tests, and as this involves but little time or trouble, it is advisable to make it an invariable practice, however perfectly the work may seem to have been carried out.

The smoke-test is handy and fairly reliable. It consists in filling the drains with smoke, so that it may find its way through any faulty joint or defective trap, and thus demonstrate by its presence, near to or within the house, the exact site of each of the various faults. It must be remembered that where smoke can penetrate, sewer gas may, and the ocular demonstration of the danger to which the inmates of the house are exposed, will often be the means of convincing them of the necessity for certain alterations, which might otherwise meet with opposition, on account of the expense or temporary discomfort they involve. There is nothing like smoke to convince a sceptic that the suggestions of an expert have a solid foundation in fact, and are not, what they are too often supposed to be, the outcome of a theorist's imagination.

In applying the smoke-test, one of the various apparatus that are made for the purpose must be used, and the best opening at which to blow in the smoke is the air-inlet to the drain on the house side of the trap which disconnects it from the sewer or cesspool, or, failing this, it may be introduced at any convenient trap, by removing its water-seal. As soon as the smoke is seen to issue from the various soil-pipe or drain-ventilators, they must be plugged, as all are then charged with smoke, and afterwards a little pressure applied by the apparatus, not sufficient, however, to force the various traps, will send the smoke

through all imperfections, if it has not already found its way through, which is more than likely.

For small systems of drains, handy little machines are made which answer the purpose, but it is well to use one of the larger apparatus, such as Burn & Baillie's (Fig. 88), in the case of large premises. This apparatus consists of a double-action bellows, which communicates with a cylinder in which the smoke is generated by burning oily cotton-waste, and from which it is carried by a pipe into the drain. At the end of this pipe a flange surrounded by an india-rubber ring is fixed, which acts as a plug when introduced into the drain; these are made of various sizes, to suit different sized pipes. By means of an ingenious contrivance connected with the cylinder this apparatus can determine whether any leakages exist previous to their exact position being demonstrated by the smoke. This is managed

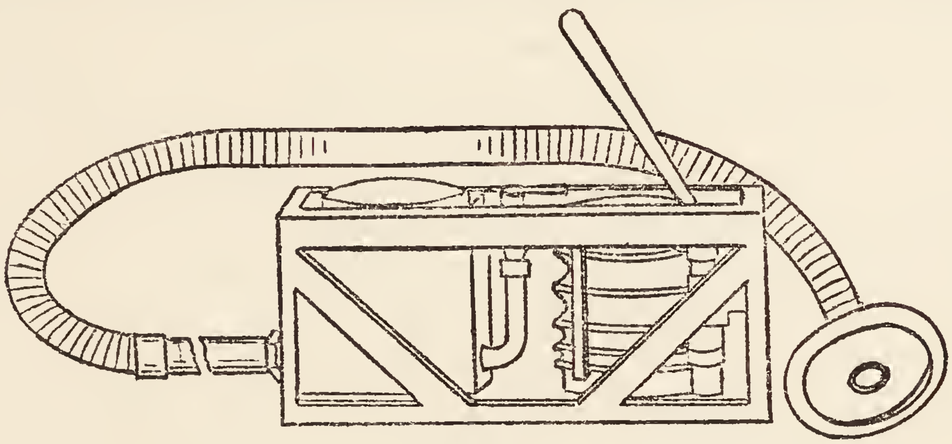


Fig. 88.

as follows:—Round the cylinder is an outer casing containing water and supporting a float, which is raised with a few strokes of the bellows; provided there is no leakage at any point, the float will remain in its raised position; on the other hand, it will fall if the slight pressure of air that maintains it is lost through leakage. There is not much advantage gained by this, as, if leakage is demonstrated, it is afterwards necessary to make use of the smoke, in order to establish where the faults are.

Smoke rockets are sometimes used for testing drains, and they have often been instrumental in exposing faults, but they can in no way compare with an apparatus such as has been described. Having ignited the rocket, it is introduced at the terminal end of the drain, which, of course, must afterwards be plugged.

Oil of peppermint is also used as a drain-tester, although it cannot be compared with smoke in efficiency. It may either be

discharged down the soil-pipe (from 1 to 2 ounces, followed by a few cans of boiling water), or introduced at a trap on the soil-pipe drain. The same precautions with regard to sealing up all ventilators is necessary in this case also, and if the trap is the place selected, it must afterwards be thoroughly covered with wet cloths to prevent the odour of the peppermint from escaping at that point. The person who introduces the oil ought not to be the one to search for the smell of it about the house, as the slightest particle of it on his hands or clothes will suffice to distribute its scent wherever he goes, and so blunt his power of detecting any escape. Also, if the peppermint should be introduced from a water-closet, the operator must remain in the closet until such time as others can satisfy themselves with regard to the soundness of the various connections.

Water Test.—The integrity of drains may be thoroughly tested by filling them full of water, until it reaches the level of one of the traps, having carefully plugged the outlet into the sewer or cesspool. If the water remains at the same level for about an hour, the drain may be pronounced sound; on the other hand, should it subside, leakage must be taking place, either from imperfect joints or fractured pipes. In order to discover which section of the drains is at fault, each must be tested separately. To apply this test to soil-pipes, even if practicable, would not be reasonable; the smoke test in that case fulfils all requirements, as it at once reveals any leakages arising from imperfect joints or other faults. All new drains before they are covered in should be tested with water as described.

CHAPTER VII.

SEWAGE AND REFUSE DISPOSAL

THE practice of discharging sewage in its crude state into streams, although contrary to law, is still by no means an uncommon one, and the question of sewage disposal is occupying the attention of a good many sanitary authorities throughout the country. The Local Government Act of 1888 imposes the duty on County Councils of enforcing the provisions of the Rivers Pollution Prevention Acts, and this duty is being exercised in some counties with excellent results, although in others little attention appears to have been given to the question.

In those counties where active measures have been taken by the County Councils, authorities who, hitherto, have failed to realise their responsibility as guardians of streams, have been compelled to provide proper disposal works. That the question is no easy one to settle has been demonstrated over and over again by failures on the part of many authorities in obtaining good results notwithstanding large outlays of money.

It must be understood at the outset that treatment to be effective must accomplish more than simple clarification. It is possible by several methods so to treat sewage as to remove practically all the suspended solid matters, leaving a clear fluid which, in appearance, may differ only slightly from potable water; but this treatment alone will not render the sewage fit to be discharged into a stream, for it still contains *in solution* an immense amount of *organic matter*, which, as decomposition proceeds, will become turbid, and give rise to nuisance from deposit on the bed of the stream of putrefying solid matter. The process, to be complete, must go further than this: the soluble organic matter must undergo a change which so alters its nature as to convert noxious *organic* into harmless inorganic substances. At one time it was believed that the only really efficient means of accomplishing this was by submitting the sewage, after chemical precipitation in tanks, to land treatment, but recent experience has shown that equally good results may be obtained by artificial filtration, and still more lately it has been demonstrated that,

in the case of ordinary domestic sewage at any rate, the preliminary precipitation process is not essential, and that the solid organic matter may, to a large extent, be liquefied and so prepared for further treatment (either by land or artificial filters) by much simpler and less expensive methods to be presently described.

In order to appreciate the importance of certain conditions indispensable to successful sewage treatment, it is necessary to understand the operation of the process.

Sewage when brought in contact with suitable land, or properly constructed artificial filters, is immediately attacked by living organisms (*bacteria*) universally present in the upper strata of the soil and in sewage, and which in time develop in the interstices of filters ; by these its organic matter is split up into simple constituents, which, with the assistance of the oxygen and carbonic acid gas present in the ground air or the air in the filter, unite with certain mineral bases in the soil and in the sewage itself, and thus are transformed from organic, unstable compounds, liable to putrefactive changes, into more fixed inorganic salts of an innocent nature.

The chief requirements, therefore, essential to success, are land or artificial filtering media which are permeated throughout by microscopic life, and of such a consistency as will allow of the free penetration of air.

Before describing the methods more in detail, let me here emphasize the fact that a profit must not be looked for from any system of sewage treatment. If, in the case of land treatment, the returns cover the working expenses, that is as much as can reasonably be expected. It must be remembered that the first consideration is the effectual treatment of the sewage ; if this can be accomplished at a profit, well and good, but no profit will justify any sacrifice of efficiency in this respect. Failure, in many instances, arises from too much thought being given to what is best for the crop, little consideration being paid to efficient sewage treatment. For this reason, it is important that sewage farms should be under the direct management of the Sanitary Authorities, in place of being let to farmers, whose interests are not, or may not be, in conformity with the principles of sewage treatment.

The methods of sewage disposal have now to be considered, and these have to be viewed in the light of the principles just laid down, always remembering that, although the details must necessarily vary with circumstances, none are right which do not comply with established rules.

To give anything approaching a detailed account of the various recognised plans of sewage treatment would far exceed the limits of this elementary treatise, the following short description, however, of the systems most in favour may prove of service.

The methods in use, singly or in combination, may be considered under the headings **chemical precipitation, subsidence, anærobic liquefaction, ærobic tank treatment** (activated sludge method), **artificial filtration, contact beds, land filtration,** and **broad irrigation.** The question as to which is to be preferred does not admit of a simple answer, but can only be determined by carefully considering the local conditions and the nature of the sewage—duties which belong to engineers and chemists.

Precipitation consists in collecting the sewage in tanks, and allowing it to remain for a time either absolutely at rest or comparatively quiescent, so that the solid particles may subside. This process is assisted by the previous addition of some **precipitant,** in the shape of lime, alum, salts of iron, or other substances, either singly or in combination. The fine particles of lime, and the flocculent particles which form from the salts of aluminium and iron, by reason of their density assist in the subsidence, the solid sewage particles being entangled and carried to the bottom of the tank in the form of **sludge,** leaving a comparatively clear fluid above. Chemical precipitation is a useful, and, possibly, in some cases a necessary preliminary to further treatment, but in itself *it does not sufficiently purify the sewage to warrant its being discharged into a stream.**

By using precipitants, provided they are selected with due regard to the nature of the sewage, and added in such proportions as varying circumstances indicate, the subsequent treatment, whether by land or artificial filtration, will be simplified; in fact, it is probably underestimating the benefit which results from the precipitation process, when properly applied, to say that by its means two-thirds of the impurity the sewage contains may be removed.

Precipitation, however, as a first stage in sewage disposal, is now in most cases superseded by simpler and less expensive methods to be presently considered.

Precipitation tanks, as usually constructed, are large and shallow, and they are worked either on the **continuous flow** or the **quiescent** systems, the former being the one now generally

* It is suggested in the final report of the Sewage Disposal Commission that the degree of purification required may be governed by volume of river water into which the effluent is discharged.

adopted. Two or more main tanks are provided, and these are subdivided by partitions which do not reach quite to the surface of the tank. The sewage enters in a shallow stream over a weir extending across the whole width of the tank, and it passes in like manner over the dividing walls and into the effluent pipe over a similar weir at the other end. By this process the sewage is kept sufficiently quiescent to allow precipitation to take place, and, periodically, say twice a week, the tanks are emptied, by means of what are termed **floating arms,** to allow of the removal of the sludge which has been deposited, and when this is going on the duplicate tanks are made use of. If the fall will allow of it, the tanks are emptied by gravitation, but when this is not possible the floating arms discharge into a well from which the effluent is pumped for further treatment. As regards the sludge, it gravitates to a central channel with a fall towards a sludge well, from which it is removed, if possible, also by gravitation, or if not, by means of a pump, for ultimate disposal by one or other of the methods to be described presently. It is essential to remove the sludge and cleanse the tanks at short intervals, so that the tank capacity may not be curtailed more than need be by deposited sludge, a condition of things which would greatly impair the result.

What is known as the **Dortmund tank** is a deep tank of special design, which is now largely adopted in this country. It cannot be said that it has yet been proved to be superior to the ordinary tanks, but the chief arguments in its favour are the lessened cost of construction and the ease with which the sludge can be removed.

The sketch (Fig. 89), which represents, in section, a tank of this description designed by Ives of Derby, will help the reader to understand its construction. It is circular in shape, about 30 feet deep, and has a cone-shaped bottom. The sewage, after the addition of precipitants, is carried two-thirds down the tank in a pipe, A, which terminates in a series of radiating arms, B, with openings along their under surface through which it is discharged in such a manner as to cause as little agitation as possible of the sewage already in the tank. The comparative quiescence of the sewage in the tank allows precipitation to take place, and the action is intensified by the incoming sewage having to pass upwards through the sludge which has formed and is settling, and which acts as a mechanical filter, and by the time it reaches the outflow pipe, C, very satisfactory clarification has been effected. By means of a pipe, D, which reaches to

the bottom of the tank, the sludge is raised, and this process can go on while the crude sewage continues to enter the tank, indeed, if sufficient fall is available, it can be conducted automatically by the following arrangement :—It will be noticed that the sludge-pipe, D, leaves the tank at a lower level than the effluent outgo, consequently, the pressure exercised by the weight of sewage above the outgo of the sludge-pipe suffices to raise the sludge from the bottom of the tank in a continuous stream. If the fall will not allow of the sludge-pipe being taken off at a lower level than the effluent outflow pipe, the sludge must be raised by means of a pump. In any case it is necessary to provide

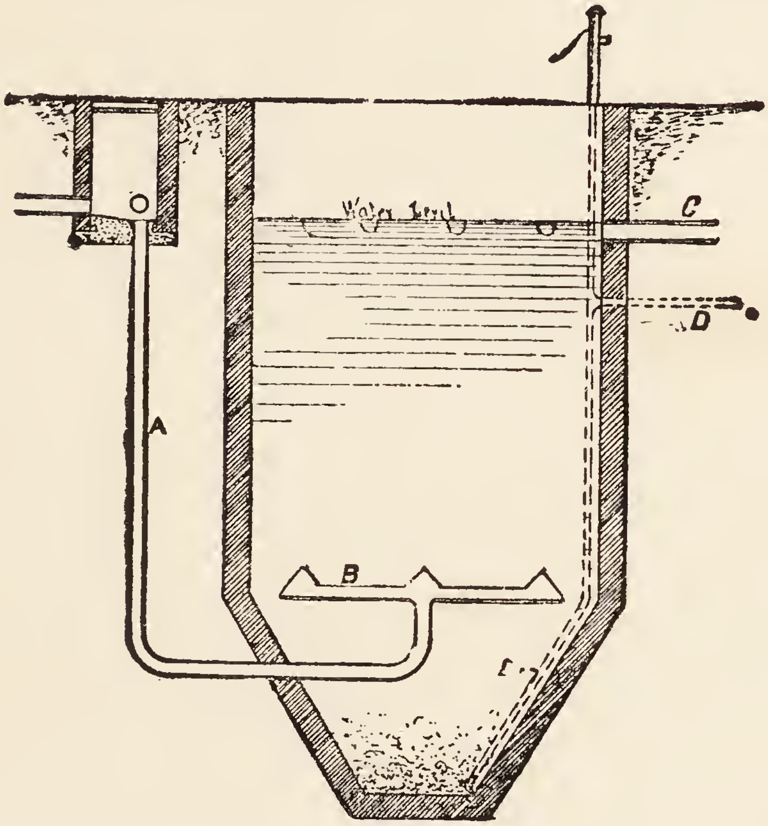


Fig. 89

a pump in order to allow of the emptying of the tank both of sewage and sludge when occasion requires.

The International Sewage Purification Company have designed a similar tank, with the exception that the bottom in place of being cone-shaped, is flat, and close to the bottom there are a series of revolving rakes which are worked either by hand or by steam power according to the size of the tank, the object being to prevent the sludge from clogging. At the same time, those who have had considerable experience of the working of the Ives tank maintain that no such trouble is experienced.

It is sometimes suggested that these tanks are capable of producing an effluent of sufficient purity to be discharged into a stream, but this is not the case, they simply act as other precipitation tanks do—namely, as clarifiers of sewage.

By **subsidence** is meant tank treatment without the use of precipitants, the sewage being allowed to remain a shorter period in the tanks than is necessary in the case of the methods to be presently described, by which the organic suspended solids are liquefied by bacterial processes. The clarification effected by subsidence only is less perfect than when precipitants are used; on the other hand, the cost of chemicals is saved.

Methods of Dealing with the Sludge.—The sludge is dealt with in a variety of ways. In the case of small towns conveniently situated in agricultural districts, farmers will usually undertake to remove it without further treatment, free of charge, and in some cases they will even pay a small sum for the privilege. This method of disposal of the sludge is not usually satisfactory, as it is often allowed to remain on the spot for a long period while decomposition is going on, until it may suit the convenience of the farmer to remove it.

In some cases the sludge is pressed into cakes in filter presses, and sold or given away as manure, or burned and manufactured into cement. The question of dealing with the sludge is not the least difficult one in relation to sewage disposal.

Before describing the methods in use for completing the process of sewage purification, it will be convenient to describe shortly certain processes which are now generally adopted, and which have almost entirely superseded chemical precipitation, at any rate in the case of ordinary domestic sewage, and, at the same time, greatly simplified the sludge difficulty; I refer to what are known as *biological* methods of sewage disposal. This term is really somewhat misleading, as the final stage of all methods of disposal, whether by land or artificial filtration, is a biological or, in other words, a bacterial process. The novelty, then, consists in taking advantage of Nature's methods in order to effect the whole purification process and not merely the final stage of it.

That sewage can be successfully disposed of by chemical precipitation followed by bacterial filtration of the clarified effluent is now a matter of ancient history, but it is only lately that the fact has been demonstrated that the entire process can be effected by biological means. We now know that it is quite practicable to effect the liquefaction of a considerable portion

of the organic solids by biological methods, and so get rid to a large extent of the overwhelming sludge difficulty by presenting an increased proportion of the organic constituents of sewage in a soluble form for the final biological change. We may not yet be in a position to say which of the biological methods at present recommended is the best, and no doubt this will largely be governed by the circumstances in each case (character of the sewage, etc.), neither can it be said that we have arrived at finality in our knowledge as to the best means of availing ourselves of Nature's processes, but that we are on the right lines is perfectly certain.

There are two methods at present in practical use for the preliminary treatment of crude sewage by biological processes, the organisms employed in the case of one being anærobic, and in the other ærobic; in other words, in the first air is excluded from the tanks, whereas in the latter aëration is encouraged.

The anærobic method, which is known as the "**septic tank method,**" was introduced by Mr. Cameron, the City Surveyor of Exeter. It consists simply of a covered tank of a capacity equal to from 16 to 24 hours' flow of sewage, and the liquefaction process is brought about by the multiplication of the organisms already in the sewage. In order that the sewage may be disturbed as little as possible, the inlet as well as the outlet are submerged. That very material liquefaction of the suspended organic solids does take place in this tank there can be no question, but whether the method is the best way of accomplishing this may be open to question. The cost of constructing covered tanks to deal with a large volume of sewage is undoubtedly a strong argument against the method, but since it was proved, at Manchester, Birmingham, and elsewhere, that the covering is unnecessary, the system has been very generally adopted.

This method does not necessitate a loss of fall, an important consideration in many places.

The other method of preparing crude sewage for the final purification process is by means of **large-grain ærobic biological filters,** although in this case also the process of liquefying, digesting, or peptonising the solid organic matter in the sewage is no doubt partly an anærobic one. The crude sewage, after subsidence of the heavier mineral particles in a detritus tank (a precaution which is also necessary in the case of the method just described), is passed downwards through a filter of large particles. The filter, or rather, as it is named in this case,

contact-bed, is worked intermittently to allow of aëration, and it is while resting, in all probability, that the liquefaction of the organic solids entangled in the filter is in most active operation.

As a substitute for septic tank treatment, Dibdin advocates the use of contact beds formed of slate slabs built one upon another with interspaces. Into these beds the crude sewage, after straining and subsidence in detritus tanks, is discharged direct, and it is claimed, no doubt rightly, that the liquefaction of the organic suspended solids is affected by ærobic organisms, resulting in the production of an inoffensive effluent for final treatment by land, fine contact beds, or filters, as the case may be.

Granting that the two last-mentioned methods are as efficacious as the first one, a point which will be discussed presently, theoretically they ought to have the preference, as the process, being ærobic, is a more wholesome one; it must be remembered, however, that it involves a loss of fall.

So far, we have been considering the preliminary process of sewage disposal only, except in so far as it was necessary, from an explanatory point of view, to refer to the final purification processes, these latter have now to be considered in detail.

Having liquefied the sewage either in large-grain filters or contact beds, or in the septic tank, there can be no question that our whole efforts should then be directed to the establishment of as complete ærobic conditions as possible in order to bring about nitrification, which is the final change necessary to allow the sewage to be discharged into a stream without the risk of subsequent putrefactive changes taking place.

It may be convenient at this stage to refer to a method of treatment by which the entire process of purification is accomplished in tanks without subsequent treatment by filtration or on land—namely, the **activated sludge** method.

The pioneers of this method are Prof. Fowler, Mr. E. Ardern and Mr. Lockett, of Manchester; Mr. W. H. Duckworth and Mr. S. E. Milling, of Salford; and Mr. Caink, of Worcester. The method has also been very thoroughly investigated in America, and the construction of plants on a large scale at Milwaukee, Chicago, Texas, and other places in the United States is in contemplation.

This method involves no departure from the established principles of sewage disposal, but merely a change in their application, the necessary oxygen being provided by driving

air into the sewage in the tanks in such a manner as to bring it into intimate contact with the crude sewage after fine screening only. By this process the growth of nitrifying organisms is encouraged, and, when activity is once established, the purifying process is a continuous one as long as sufficient tank capacity is available and the air pressure is adequately maintained. It has been established that ordinary domestic sewage may thus be purified in tanks of a capacity equal to six to ten hours' flow. On the other hand, twice these capacities may be necessary in the case of some sewages containing trade wastes.

After the aëration treatment it is necessary for the effluent to be passed through subsidence tanks to separate the sludge, and the latter has to be disposed of. This sludge, owing to its colloidal character, does not part with its water very readily; on the other hand, it is of considerable value from a manurial point of view owing to its high nitrogen content.

Had it not been for the war, no doubt this method of disposal would have developed more rapidly than it has done, but at the present time it is in operation at Witlington Sewage Works, Manchester, Worcester, Stamford, Stoke-on-Trent, Birmingham, Sheffield, and Salford. Its adoption in preference to other methods is a matter of relative cost, having regard to the quality of the sewage and local circumstances.

There would also appear to be room for development in the details of the application of the system. Mr. J. E. Willcox, in his inaugural address as President of the Association of Sewage Disposal Works Managers, called attention in August, 1918, to the following, among other practical problems, which still have to be solved:—

(*a*) The reduction of cost of the plant; (*b*) the best method of maintaining the bottom velocity in the aëration tanks in order to avoid the deaëration of the sludge, and so prevent it from becoming septic; (*c*) means of readily emptying aëration tanks in order to attend to the air diffusors; (*d*) improved means of sludge disposal; (*e*) provision for dealing with storm sewage in such a way that the efficient working of the plant may not be periodically disturbed, etc.

Time will tell whether developments will result in this method of treatment establishing itself as being superior to other well-tried and established methods. After all, the determining factor will be relative cost, and it may be that local circumstances may, from that point of view, turn the scale in favour of this method.

Intermittent downward filtration is the term applied to that form of land treatment in which the effluent drains are laid at considerable depth, 5 or 6 feet below the surface, and in which the sewage (after precipitation or other preliminary treatment) is turned on for a certain number of hours (8 hours), with intervals (16 hours), during which it is entirely kept off to admit of free aëration of the soil. The clarified sewage is conveyed in open carriers along the surface, and by a system of sluices it can be directed on to any part of the area which has previously been specially levelled and underdrained. The great object is to bring the sewage at regular intervals in contact with the soil, irrespective of any vegetation, but, by an arrangement of ridges and furrows, certain root crops may be cultivated, and in this way the process of purification may be assisted, while at the same time a small return is obtained from the sale of the produce. By such a system, properly attended to, and where the soil is particularly suitable, it is said that the sewage of from five hundred to one thousand inhabitants (if previously thoroughly clarified by precipitation) may be dealt with on 1 acre of land.

Broad land irrigation is very similar to land filtration, with the difference that greater attention is paid to the cropping of the land. The area of land used is very much larger, and the sewage is discharged from surface carriers at such times and in such quantity as vegetation requires, or will admit of. The carriers are cut about 30 feet apart, along ridges, with a gentle slope on each side to admit of uniform distribution of the sewage. Constant attention is required to insure that the sewage is thoroughly distributed and not allowed to discharge on to a small area, as this would cause waterlogging, and thus prevent the proper aëration of the soil. The land, in this case, is drained at a depth of from 3 to 4 feet, and the quantity of land required is said to be 1 acre for each hundred of the population, provided no previous treatment beyond straining is in use; with preliminary treatment, however, by precipitation or otherwise, the sewage of twice as many people, if not more, may be dealt with on 1 acre of suitable land. Irrigation with crude sewage, however, usually ends in failure.

Italian rye-grass is the most suitable crop for sewage-farm cultivation, as it grows very rapidly and absorbs a large quantity of moisture. As many as three or four excellent crops may be cut during the year, and it yields a fair return as a food for cattle. Root crops and cabbages may also be cultivated, but all crops

which do not admit of the regular rotation of the sewage over the whole area at short intervals must be avoided.

Biological filtration may become a necessary expedient in cases in which suitable land is not available, or as an adjunct to land treatment where sufficient land cannot be acquired. Indeed, so successful have modern artificial filters proved to be, when intelligently constructed and managed, that many now prefer them even to good land.

When artificial filtration was first introduced, the filters were composed of sand and gravel in combination with **charcoal,** or certain proprietary materials, such as **polarite** and **magnetone,** but, as it has now been proved that excellent results may be obtained by using simpler and less expensive materials, it is unnecessary to occupy space in referring to these discarded substances.

For some years, extensive experiments with simple artificial filters have been conducted by the State Board of Health of Massachusetts, and these were followed by similar work in this country, which has greatly added to our information, and it may now be said that the system is thoroughly established as a reliable and conveniently available method of sewage disposal.

It does not seem to matter very much what material is used for filters and contact beds provided certain essentials are complied with—namely, hardness, non-friability, stability—that is, freedom from liability to disintegration, either by chemical or mechanical action, and the absence of dust. Among the different materials used for the purpose may be mentioned coke breeze, coal, clinker, broken gravel and shingle, granite, slag from iron works, broken saggers (a hard-burned clay refuse from potteries), ashes, and burned ballast. With the exception of the last two, all the materials mentioned answer the purpose well; but, as regards ashes and burned ballast, the former is frequently found to crumble and cause clogging, while it is difficult to insure that the latter is sufficiently hardened by the burning process to prevent its caking and becoming useless.

Coke breeze was first recommended as a satisfactory medium for filters by Mr. Dibdin, late chemist of the London County Council, after he had tried it in a one-acre experimental bed at the London outfall. Since then it has frequently been employed, and it appears to yield satisfactory results.

Coal, in the form of fine slack, free from dust, was introduced as a sewage filtering medium some years ago by Mr. Garfield, at that time engineer in charge of the Wolverhampton Sewage

Disposal Works, and since then it has been thoroughly tested by the author and several others who are interested in the subject in the Midland Counties, with excellent results. For some time the high price of coal has proved prohibitive to its use in most districts, but if the price should fall to a reasonable figure engineers need have no hesitation in again recommending its use as a filtering medium.

As a matter of fact, however, any refuse substance available in the particular locality may with safety be recommended, so long as it complies with the essentials set forth above.

Filters at first merely act as mechanical strainers, but in time they all acquire the power of acting chemically on organic matter, through the agency of bacteria which develop in their interstices, success depending upon the thorough aëration of the filters.

Here it will be convenient to refer to two methods now adopted in charging filters, or bacteria beds, as they may more appropriately be termed—one in which the sewage is run on to the surface of the bed, and regulated so as to pass through it in such volume as shall not lead to water-logging, the operation being conducted continuously or intermittently, the aim being uniform and fine distribution; the other in which the outlet is closed and the bed is filled to its utmost capacity, the sewage being allowed to remain in contact with the particles of the bed for, say, two hours, after which it is suddenly run off, and the bed is allowed to stand empty for a similar period for aëration. The author has tried both methods under identical conditions, and he has no hesitation in saying that, in his opinion, far better results are obtained by the first than by the second, which is known as the *contact* method.

On the face of it, in view of the fact that thorough aëration is an essential, one would expect to obtain better results from filtration than from contact, and this has all along been the author's experience. No doubt the contact method has its advantages from a practical point of view, as it is a comparatively simple matter to fill and empty a tank at intervals, whereas it is not easy to provide for the uniform distribution of the sewage over the surface of a large area of filter. This is a consideration, however, which must not be allowed to weigh against all-important essentials, and the difficulty now may be said to have been solved, as several good distributors, both automatic and power-driven, are now available.

Opinions differ regarding the most effective size of particles for filters. Some favour large particles of from $1\frac{1}{2}$ to 3 inches,

but, in the opinion of the author, the smaller the particles are, compatible with thorough aëration, the better.

Artificial aëration of filters by mechanical means has been tried, on an experimental scale, in Massachusetts, and in this country by Lowcock, but, so far, it has not been demonstrated that the results justify the extra cost entailed.

On comparing the merits of contact and filtration, as applied to bacteria beds, it must be remembered that double contact—in other words, the duplication of the process—is essential if an effluent is to be produced approaching the standard of purity of that from a single filtration process with efficient and uniform distribution. Up to the present time, however, no automatic

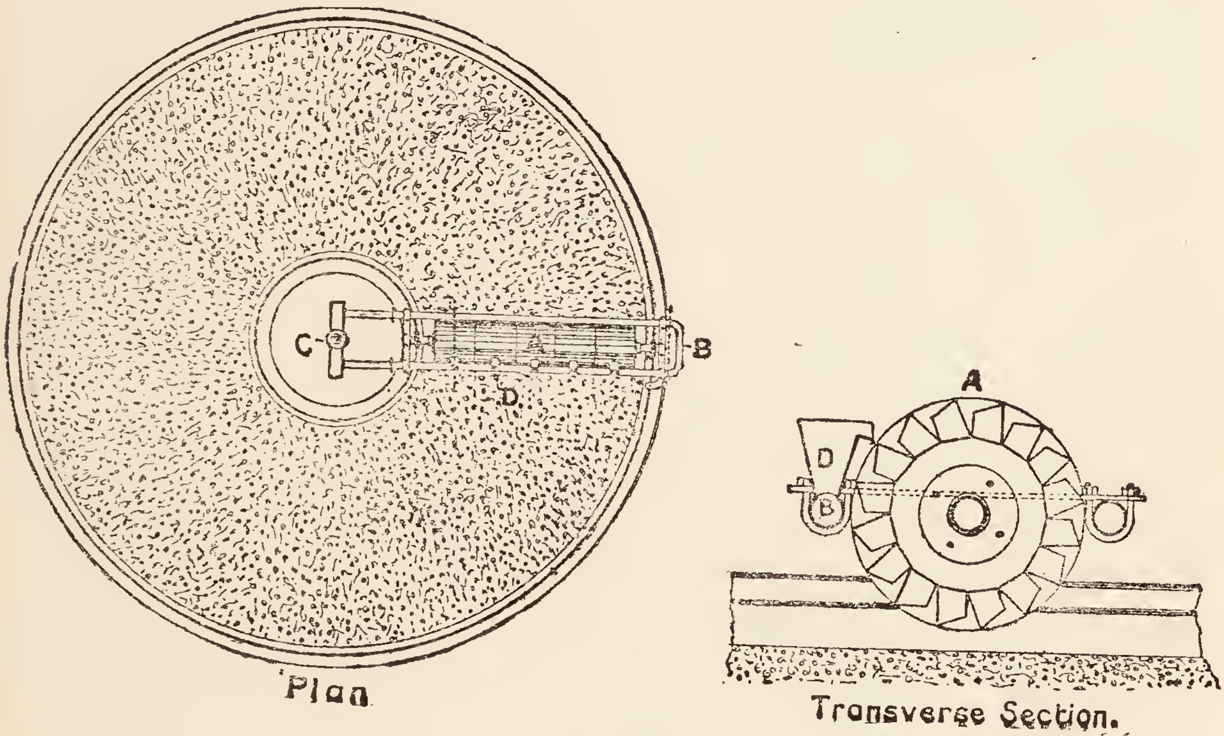


Fig. 90.

distributor has been brought out which, having regard to wind conditions, can be said to comply fully with the requirements in the case of large filters. The nearest approach to this, in the author's opinion, is the Fiddian distributor, shown in plan and section (Fig. 90). One great advantage in this distributor is that the sewage, no matter how small the flow, suffices to move the apparatus without being held back in tanks which automatically discharge at longer or shorter intervals, according to the varying volume. Also, the Fiddian distributor works with a much smaller head of sewage than any other automatic distributor. A glance at the figure will suffice to explain the

principle and mode of action of this apparatus. It consists of an elongated water wheel, A, of from 9-in. to 18-in. diameter. Encircling the wheel is a tubular radial arm, B, connected with a vertical central pipe, C, through which the sewage is delivered from the tank. Connected with the radial arm are a series of short upright rectangular shafts, D, with weir openings on the sides next the wheel, and the latter is divided transversely into sections to insure even distribution, the delivery of sewage to each section being regulated by increasing the width of the weirs from the centre to the circumference. The distributor travels round the bed on wheels, running on rails, the motive power being the sewage, and the rate of travel varies with the flow. One outer rail only is sufficient for filters of small diameter, but for large filters one or two extra tracks are necessary, and these are supported on light cast-iron columns. The author has had an opportunity of testing this distributor in practical operation, and he considers it compares favourably with other automatic distributors in every respect.

The nearest approach to absolute uniformity of distribution, however, can only be insured by employing power-driven distributors. The Willcox and Raikes distributor is an excellent apparatus of this type applicable to a longitudinal filter, the tank effluent being delivered by syphon action to two travelling arms, right and left, from a longitudinal fixed trough extending from end to end along the middle of the filter. In this case, the motive power is a fixed electric dynamo, working gearing connected with an endless cable attached to the distributor, which is thus propelled longitudinally forwards and backwards over the filter. While the distributor is travelling in one direction the effluent is being delivered from one arm only, the other half of the filter being at rest, but on the return journey the syphon discharge is reversed automatically and the other arm, supplying the other half of the filter, is brought into action, thus allowing the two halves to be worked alternatively.

Distribution by means of sprays has been tried, and is still in operation at certain works; for example, at the Birmingham, Tame and Rea, Sewage Disposal Works, and at Lichfield, but by this method the question of nuisance from smell becomes a vital one where the works are even in moderate proximity to houses. Moreover, it is difficult to secure by this method sufficient uniformity of distribution, and, in consequence, while parts of the filter are not doing their share of the work, other parts are overtaxed. In certain cases, as at Chesterfield, where this method

of distribution was adopted, complaints and threats of proceedings at law have led to the substitution of one or other of the methods previously described.

As regards the delivery of sewage or tank effluent to contact beds, various appliances are available which automatically bring into action in regular rotation each series of beds. In this case, uniformity of distribution over the surface of the beds is not an essential condition, hence the problem is a comparatively simple one.

Among other questions connected with sewage purification by means of artificial filters which still have to be settled is the depth of filter required to produce the desired result. In the case of large particle filters, depth is, no doubt, of importance, by reason of the relatively small area for bacterial growth, as well as the rapidity with which the sewage passes through. If the filter particles are fine, on the other hand, say $\frac{1}{8}$ to $\frac{1}{4}$ inch, the depth may be greatly reduced; in fact, it would appear that to construct such filters of a depth of 5 or 6 feet (the usual practice hitherto) is extravagant and quite unnecessary. This was demonstrated some years ago by the author in the case of a fine-grain filter ($\frac{1}{8}$ to $\frac{1}{4}$ inch) formed of broken saggars, a hard burned clay pottery waste, which had been in constant work for about three years in a town in Staffordshire. This filter, the depth of which was 4 feet 6 inches and the area a quarter of an acre, was constructed with the view of determining whether single filtration after septic tank treatment would satisfactorily purify the sewage in question given perfect distribution by a Willcox and Raikes power-driven apparatus which had been provided.

Having proved conclusively that the work done at a constant delivery rate of 200 gallons per superficial yard per 24 hours was excellent, it was then determined to carry the investigation further in order to ascertain whether a shallower filter would prove satisfactory. Accordingly the filter was tapped at different depths, four rectangular shallow trays with perforated covers being introduced at 1, 2, 3, and $4\frac{1}{2}$ feet from the surface respectively, a pipe being carried from each tray through the wall of the filter for the collection of samples. In order that the upper trays might not interfere with the results from the lower ones, they were placed obliquely from above downwards so that each had an uninterrupted section of filter immediately above it. During the six months occupied by the experiment (making over three years' continuous working of the filter), numerous

samples were collected for analysis, and the results proved to be most interesting.

Before commenting upon these results, it may be mentioned for the information of those who are not familiar with analytical methods, that the reduction of the free ammonia, albuminoid ammonia, and oxygen absorbed in the effluent compared with the sewage, especially the two last mentioned, affords a very good index of the efficiency of the work done in converting the putrescible organic matter into more stable non-putrescible substances. On the other hand, the amount of nitric nitrogen

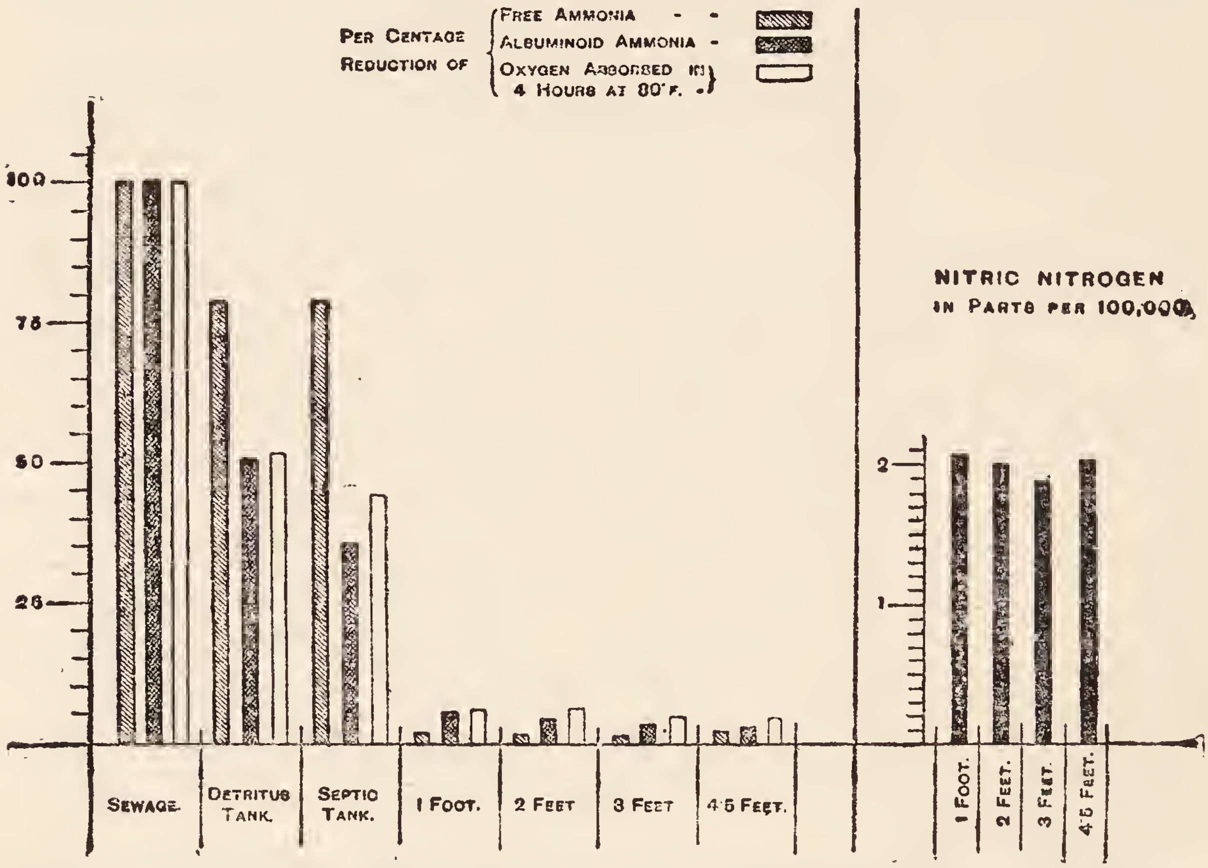


Fig. 91.—Diagram showing Degree of Purification as estimated by percentage reduction of Free Ammonia, Albuminoid Ammonia, and Oxygen absorbed, and the amount of Nitric Nitrogen in the effluents.

in the filter effluent indicates the extent of such conversion, so that the higher the last-mentioned figure the more active the purifying power of the filter. Bearing this in mind, and disregarding the other less important figures of analyses, the accompanying diagram (Fig. 91) shows in graphic form the percentage purification effected at different depths of the filter.

Shortly, it may be stated that, in the case of the sewage in question, both as regards the reduction of the putrescible matter and its conversion into non-putrescible substances, the changes are practically completed at a depth of 1 foot from the surface

of the filter. Viewed in the light of the present requirements of the Ministry of Health as regards depth of filters and grade of particles, these results are of the highest importance. The Ministry's practice in considering plans is to pay regard to cubic capacity of filters only, and, so long as the required capacity per sewage flow is provided, the depth may be anything from 4 to 9 feet, the surface area being diminished in proportion as the depth is increased. Granting that the author's experience is generally applicable, the Ministry's position of course becomes quite untenable. The probability is that in time it will generally be recognised, first, that filters should be constructed of fine particles, and secondly, that the depth need not exceed 3 feet.*

The following short summary of the salient points in this necessarily brief account of the biological methods of sewage disposal in practical use may be of assistance to the student. To insure success the following conditions must be complied with :—

1. The removal, by means of screening and subsidence in small tanks, of the large suspended matters and inorganic solids, such as road detritus, etc.

2. The liquefaction, breaking up, or digestion of the suspended solid organic matter so as to prepare it for the final conversion into more stable inorganic compounds ; which may be effected—

(*a*) By the Cameron "Septic" tank, which need not be covered.

(*b*) By Dibdin *contact* beds formed of slate slabs.

(*c*) By large grain filters, composed of various materials, and which may be worked as filters or as *contact* beds.

3. The further conversion of the now liquefied sewage by means of nitrifying ærobic organisms in filters composed of various materials. In this case also, the beds may be worked on the "contact" method or as filters.

4. The carrying out of the complete process in artificially aërated tanks (activated sludge method).

Sewage in small quantities may be disposed of by what is known as **sub-irrigation.** By this is meant the discharge of the sewage along ordinary agricultural drain-pipes, laid within 1 foot of the surface, so as to allow of its being purified by land and appropriated by vegetation. This plan is open to certain objections which render it unsuitable for cottages, singly or in small groups. The drain-pipes, unless periodically renewed, are liable to clog, and there is a danger of the sewage not being uni-

* For a full account of the observations and conclusions based upon the working of this plant, see a paper by the author on "Nitrification of Sewage," *Proceedings of the Royal Society*, B, vol. lxxix., 1907.

formly distributed over the whole area unless after subsidence it is passed into a tank which will periodically and automatically discharge it in considerable volume along the drains. These are conditions which may be practicable in the case of villages and large establishments, and in such cases the plan is a good one.

In certain villages and schools where this system has been successfully adopted, the sub-irrigation drains have not required cleaning for from ten to fifteen years.

It may be well, however, to caution those who propose to give it a trial, that, as success is dependent upon the nature of the soil, and upon the manner in which the scheme is carried out, it is essential that it should be entrusted to one who has had experience in such work; indeed, the services of an engineer, whatever the scheme may be, are distinctly advisable, and in the end will prove economical.

Cesspools, without overflows, properly constructed and ventilated, and placed a safe distance from house wells, will probably be found to answer best for small houses and cottages in the country, where no system of sewers exists. The cesspool must have a pump attached to it, to allow of the contents being regularly removed and placed on the land. In the case of larger houses, with land available, an overflow-pipe for irrigation purposes may be connected with the cesspool, which ought to be of small capacity. Means of easy access must be provided to admit of occasional removal of the solid deposit.

Cesspools constructed of porous brickwork, which allows of percolation through the bottom and sides, ought in all cases to be condemned.

In cases in which cesspools are admissible—that is, when other and better means of dealing with sewage—such as by sub-irrigation—are not practicable, they must be constructed so as to be absolutely water-tight. This may be accomplished by building the brickwork in cement, rendering it with cement, and surrounding it on all sides with puddled clay from 6 to 9 inches deep, for which, of course, it is necessary to allow in making the excavation. The puddled clay is first laid on the bed of the hole, and upon it the floor of the cesspool is built; the walls, one brick in thickness, are then carried up a certain distance, and, having carefully removed all dirt from the surface of the clay-bed outside the walls, the interval between the outside of the brickwork and the soil is filled up with the clay, which must be thoroughly well rammed down; another few lines of bricks are then laid, and the interval similarly filled up, and so on

until the whole is complete. To avoid disturbing the brick-work while the process of ramming the clay is going on, care must be taken to " stay " the walls across from side to side, and the " struts " should not be removed until the cement, to some extent, has set.

An arched roof has next to be built, in which three openings must be left; one for the purpose of gaining access to the cess-pool, in order to cleanse it periodically, the second for connecting a ventilating-pipe, and the third for fixing a pump. A properly constructed manhole-cover is best for the first purpose, although a movable stone slab will answer. It is a common, though objectionable practice, in fixing the ventilating-shaft of a cesspool, to take advantage of a neighbouring tree for a support, with the result that the swaying of the tree ultimately injures the connections, and, if an iron pipe (which, however, ought not to be used for the purpose, see p. 146), breaks the joints. Some stationary object, such as a post or, if possible, a wall, must be made use of.

For the purpose of emptying the cesspool a chain pump is most suitable, as the mechanism is simple and does not get out of order.

A syphon intercepting trap must invariably be placed between the cesspool and the house, and near to the former.

The size of the cesspool must be regulated in accordance with the size of the establishment for which it is intended, but the smaller it is the better.

Before passing on to the next subject, one word of warning to those who may have occasion to consider this important question.

All new systems of sewage disposal which are brought out are presented to the public in glowing colours, and, if only one half of what is said in their favour proved to be correct when they are put to a practical trial, the question of sewage disposal need no longer trouble sanitary authorities. It is a highly technical question, and only those who are familiar with the general principles, and have had practical experience of the difficulties which have to be overcome, are in a position to advise in the matter. For this reason, it is important that local authorities of small towns in all cases should obtain the advice of experienced engineers before committing themselves to a scheme of any magnitude, no matter how plausible the arguments which are adduced in its favour may seem, or how satisfactory, to the inexperienced eye, an effluent from any works may appear to be, especially

when the visit of inspection has been arranged beforehand, and thus those in charge of the works have had an opportunity of taking exceptional precautions that everything may appear to the best advantage. As a rule, local surveyors of small towns have not had that experience which alone can qualify a person to speak with authority on the subject, and it must not be forgotten that a method of disposal which may answer in one case may prove useless in another. It is important also to remember that it is a chemical and biological as well as an engineering question, and the chemical composition of the sewage (which varies greatly in different towns) has to be taken into account in forming an opinion as to the method which is likely to prove most satisfactory.

Excrement and Refuse Disposal.

House-refuse consists of ashes, dust, food scraps, both animal and vegetable, waste paper, etc.; in fact, all waste material from a household which does not enter the drains. Under certain circumstances this mixture is likely to become a source of nuisance; it is necessary, therefore, that measures should be taken to prevent this as far as possible.

The great principle to keep in view is the checking of decomposition, as far as possible, until the refuse can be removed, therefore the removal should be effected at short intervals.

Warmth and moisture are the great agents that encourage putrefaction, and for this reason it is essential that all refuse matter, while it remains on the premises, should be kept dry and not exposed to the sun. Dry fæcal matter, comparatively speaking, does not decompose rapidly, but when mixed with water, or, what is worse, urine, the change almost immediately takes place. Garbage and all organic refuse are also likely to give rise to a nuisance during decomposition, and the same conditions favour the process in this case also.

Privies are constructed on different plans, according to whether it is intended they should receive the fæces and urine only, or also the ashes and general refuse of a household.

The drawing (Fig. 92) represents the section of a privy built for a *movable* receptacle, and for excreta only, in accordance with the requirements of the model bye-laws. In this case, the seat of the privy is hinged so as to allow of the pail being removed from the inside, but if it is found desirable to remove

it from the outside, a modification, in the shape of a door at the back or side, is quite admissible.

In order to provide for ventilation, an opening, communicating directly with the external air, should be constructed as near to the top of the privy as possible.

The floor ought to be flagged, or paved with hard tiles, or other non-absorbent material; every part of it should be at least 6 *inches* above the level of the surface of the ground adjoining, and it should have a fall towards the door of the privy of half an inch to the foot. Beneath the seat, the floor on which the receptacle rests must be at least 3 *inches* above the level of the surface of the ground, and it also should be flagged or

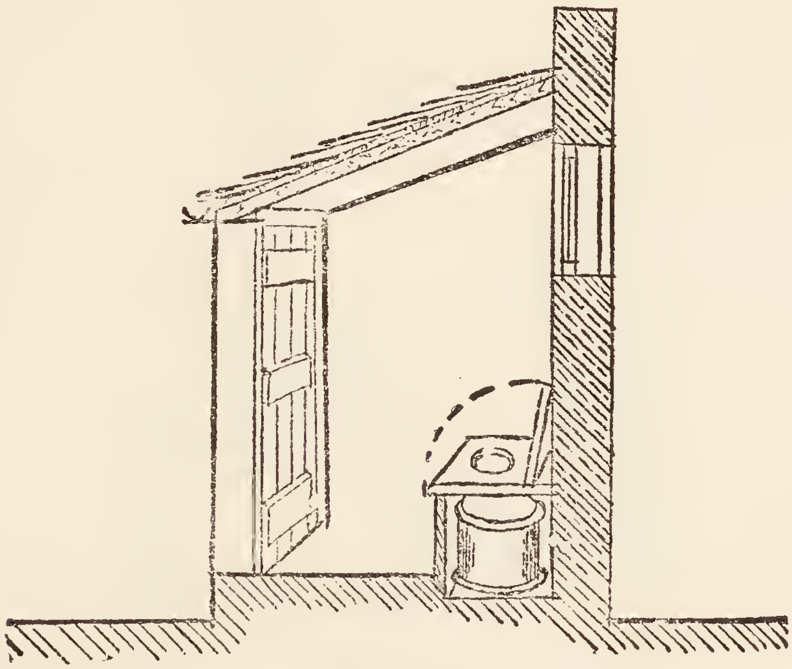


Fig. 92.

asphalted; the sides of this chamber must be constructed of flagging, slate, or good brickwork, 9 inches thick, *rendered* in cement. The receptacle itself is limited by the model bye-laws to a capacity not exceeding 2 *cubic feet.*

In the case of a privy with a *fixed* receptacle for refuse, it is essential that the ashes and dry refuse should be regularly mingled with the excreta, consequently the capacity of the receptacle must be greater than 2 cubic feet. The limit of the capacity in this case is fixed at 8 *cubic feet* in the model bye-laws. In other respects, the structure of the privy is practically the same as that just described. The great object in limiting the capacity of the receptacle, is to necessitate weekly removal of the contents. As this is hardly possible in rural districts, the above

limit must there be exceeded. The following sketch (Fig. 93) represents an arrangement which, in the author's experience, answers admirably in rural districts, and it has this advantage that in most cases it is possible to adapt it to existing privies. It will be noticed that the seat of this privy is higher than the one just described, and, for this reason, a step has to be provided. The object of this is to add to the depth of the receptacle, and at the same time to allow of its floor being above the level of the surface of the ground.

The capacity of the receptacle ought not to exceed 1 cubic yard (27 cubic feet), as, in the case of a cottage, with ordinary

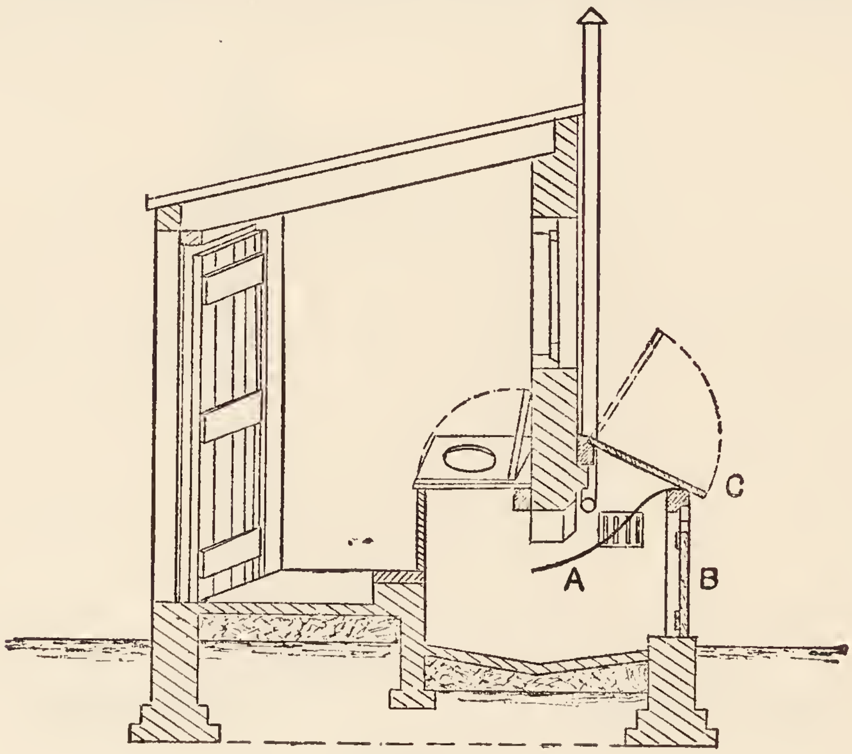


Fig. 93.

economy in the consumption of coal, this space is ample for three months' storage. By economy is meant the absence of wasteful consumption. It is a remarkable fact that the poorer classes, who can ill afford it, are most reckless in this respect. One too often sees large quantities of half-consumed coal thrown into the privy cesspit, a practice which renders the refuse useless as a manure, and for that reason the farmer, who otherwise might willingly remove it free of charge, declines to do so.

In this arrangement of privy, the ashes are thrown in from the outside at a door (C) which covers a part of the receptacle built out behind, the back wall of the privy being cut short in the form of an arch, the top of which is a little below the seat of the closet. Immediately under the lid, and fastened to

the top of the back wall of the receptacle, is a shoot (A) made of sheet iron, the sides of which are slightly turned upwards, and which is adjusted by two stays connected with the arch of the closet wall, at such an angle as to direct the ashes on to the excreta. Below this shoot there is an opening (B) in the back wall of the receptacle, which is provided with a door, through which the refuse may be raked along the slightly curved floor on to a stone slab, from whence it is carted away.

Various contrivances, connected with privies, have been introduced for the purpose of screening the ashes, but it is seldom, if ever, found that the poorer classes will make use of them.

There is one plan, however, which answers well, and that is the old fashioned one of constructing a small pit on the hearth under the kitchen fire-place—the only one that need be considered in cottage property—and covering it with a movable screen with close bars, so as to allow the finer ash to pass through, while the coarser remains behind, and can with little trouble be replaced on the fire. The author's attention was first directed to the practical utility of this arrangement when inspecting, on one occasion, a series of privies attached to a row of cottages, where the small character of the discarded ashes in each case attracted his attention. The reason of this was explained by the existence in each cottage of one of the contrivances just described. In constructing such an arrangement, it is important that the pit should not be too large, and it is an advantage to provide a tray as a receiver, which can easily be slipped out, and in which the ash which passes through the bars can be carried to the ashpit. The above sketch (Fig. 94) represents the contrivance in section. The sloping bottom, deep at the back and shallow in front, allows of the removal of the ash-tray, and admits of the pit being readily swept out.

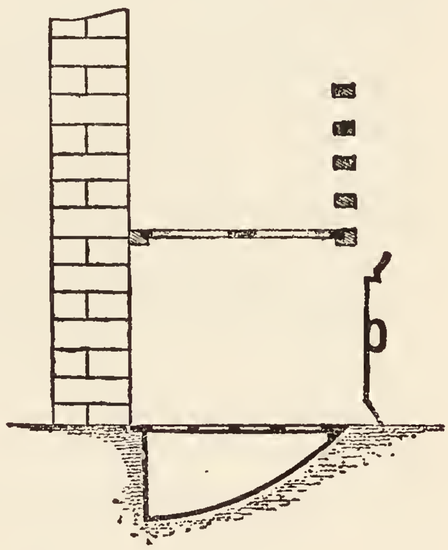


Fig. 94.

Moule's earth-closet is an excellent contrivance, but, unfortunately, it is hardly practicable for use on a large scale. In better class houses in the country, in the absence of water-closets, if soil is easily obtainable, and servants can be held responsible for the management, no better system for dealing with excretal refuse can be adopted. Ashes have little or no effect on excreta beyond

keeping them dry, and so retarding decomposition; it is very different, however, with dry soil, which not only answers a like purpose, but also gradually disintegrates the organic matter, converting it by bacterial action into the condition in which it naturally exists in fertile soil.

After the earth has remained in contact with the excreta for a certain length of time (six weeks), it may be used again, provided it is dried; indeed, it has been so used over and over again (as many as a dozen times) with perfect success.

A loamy soil is by far the best for the purpose, although clay answers very well; sand, gravel, and chalk are practically useless.

A pint and a half of earth is the necessary quantity to be applied each time the closet is used.

All of the following conditions are essential to successful treatment:—

1. The earth must be suitable for the purpose, perfectly dry, and finely sifted.

2. It should be distributed over the excreta each time use is made of the closet.

3. All moisture, beyond that contributed by the excreta and urine, must be excluded.

It is convenient to store a sufficient quantity of soil during the summer months for use during the winter, as the sun's heat may then be utilised for the purpose of drying it. If this is not done, it becomes necessary to use artificial heat, and a convenient stove for this purpose may be obtained, although the kitchen-stove answers very well.

An apparatus is manufactured by Moule's Earth-Closet Company, which may be used in connection with a fixed receptacle or a pail. It consists of a seat, above and behind which is a hopper which contains a sufficient quantity of soil to last for some time; connected with this is a valve into which the earth falls, and which is worked either by means of a handle, or by a lever connected with the seat; so that when the plug is raised, or the person rises from the seat, the soil resting on the valve is distributed over the excreta, and when the plug is pressed down again, or the seat is again sat upon, the valve is recharged.

If the closet be out of doors (it is hardly fitted for indoor use), there is no reason why the receptacle should not be of the size recommended for a rural privy (see page 174), and, provided a supply of earth is kept in the closet, the person using it may apply the necessary quantity by the hand, by means of a trowel or other convenient implement.

From the above description, it will be perfectly apparent that dry earth-closets are not admissible either for cottage property or for densely-populated towns ; in the former case, the necessary details will not be attended to, and in the latter there is no facility, either for obtaining the earth or for disposing of the manure.

The question of closet accommodation for schools in rural districts where public water supplies are not available and there are no sewers is a difficult one. Of course, earth-closets of the type just described would be admirable in such cases, but, although the initial cost would not be great, the maintenance charges would be considerable. In Staffordshire, a modification of the earth-closet system has been introduced for such schools, as the outcome of experience gained in Worcestershire, where the system had previously been adopted. This (Fig. 95) consists of a combination, in series, under one roof, of a number of closets placed back to back with a passage-way between. Under the closet seats, on each side of the central passage, is a longitudinal shallow concrete trough raised above the floor of the passage, which is also formed of concrete, and it is the daily duty of the attendant, after the school breaks up, to liberally cover the excreta with dry soil which is stored in a conveniently placed shed. Each week the contents of the troughs are emptied and carried away, and, needless to say, farmers are only too glad to remove such valuable manure free of charge.

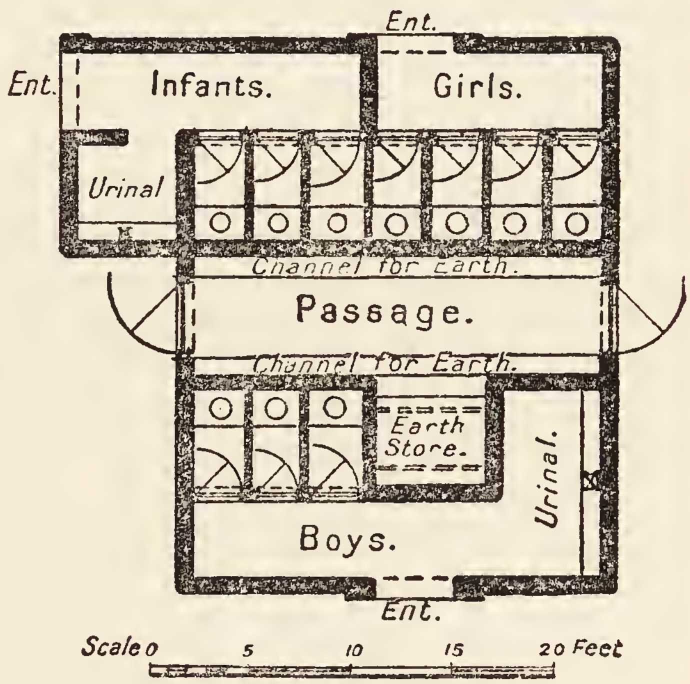


Fig. 95.

The ultimate disposal of refuse has now to be considered, but space will not permit of the question being discussed in any other than a superficial manner.

In Rural Districts, provided ordinary care is observed in excluding from the refuse heap all but the fine ashes, excreta, and garbage of the household, little difficulty will be experienced, as neighbouring farmers will willingly remove such refuse free of charge.

It is not, however, easy to insure that removal will be effected at sufficiently short intervals, and, until rural sanitary authorities throughout the kingdom realise that it is their duty, not only to see that nuisances are corrected as they arise, but also to do their utmost to prevent their recurrence, the difficulty will still continue. The inhabitants of scattered districts must necessarily do more for themselves than those who live in towns; what is quite practicable in the former case, becomes an impossibility in the latter, but this circumstance by no means relieves such authorities from responsibility. Carefully considered bye-laws, in which only what is reasonable is required of the people, should be in force in all districts, for this, as for other purposes, and by their regular enforcement, when necessary, each individual must be taught that he is expected to do his share in work that is essential to the health of the community as a whole.

In Urban Districts, sanitary authorities ought themselves to be responsible for the removal of refuse, and at intervals not exceeding a week, although daily removal is most desirable; the method of disposal must vary in accordance with the nature of the privy accommodation.

In the case of towns with *fixed* receptacles, in which the ashes are mixed with the excreta, the services of the farmer are again in request. When the surroundings are agricultural, and particularly when the proximity to a canal permits of cheap transit, comparatively little difficulty will be experienced, although the rural population may reasonably complain of the nuisance that must arise from the conveyance of such offensive matter in large quantities about the country.

In the case of towns with *movable* receptacles, the best system is what is known as the *Rochdale system*, and this, or a modification of it, is in operation in several towns. The pails, which ought to be provided with tight-fitting lids, are removed weekly, in covered carts, to a central depôt, being replaced by others which have, in the meantime, been thoroughly cleansed. A certain quantity of sulphuric acid having been added, in order, as far as possible, to retain the ammonia—the important constituent from a fertilising point of view—the excreta are discharged into iron cylinders, in which they are reduced to a dry powder (poudrette) by means of steam. The cylinders now in use have a steam-jacket around the outside, and in the interior there are hollow revolving arms for the purpose of agitating the contents; into these arms steam is introduced in order to aid in drying the excreta. The fumes given off during the

process of drying are conducted over the furnace, to prevent nuisance.

By this system, provided ashes and other refuse are excluded from the pails, a manure is produced which has a ready sale.

A modification of the Rochdale system is adopted by some authorities, the pails being emptied on the spot into a collecting cart, a proceeding which is far from satisfactory. Fresh pails, which have previously been cleansed and disinfected, should, in all cases, be substituted for those containing the excreta, which should be removed with their contents from the premises, to be subjected to a similar cleansing process previous to again being made use of. Unless this plan be adopted, the pails soon become very filthy, and cause serious nuisance. With regard to the conservancy system for urban districts, as compared with the water-carriage system, it cannot be said, even allowing that the system is efficiently carried out, that it is other than dirty, clumsy, and expensive; but when carried out as it usually is, the system becomes distinctly dangerous. It is impossible that the presence of so many centres of decomposing fæces and urine in thickly-populated districts can be other than insanitary.

Happily the crusade against conservancy methods in urban districts is now bearing fruit. In many towns privies are being systematically abolished in favour of water-closets, and one may reasonably hope that in the course of a few years water carriage will be universally established in urban areas. Apart from the benefit to public health which undoubtedly will result, it is pretty certain that the change of system will be economically advantageous. So forcibly was the economical aspect of the question brought home to the Corporation of Wolverhampton, a town of about 100,000 inhabitants, that they determined to abolish a previous charge for water of 10s. per closet and pay £2 10s. towards the cost of conversion, in each case the average total cost being £5. It is estimated that, notwithstanding this loss of revenue and the capital outlay incurred, the Corporation will effect a saving in excrement and refuse removal and disposal of no less a sum than £6,000 per annum.

The disposal of dry refuse, in water-closet towns, and in towns in which the pail system proper is in force, has recently received a great amount of attention, and authorities are beginning to realise that the practice of depositing such refuse on land must be looked upon as a thing of the past.

In these days, it is much to the discredit of authorities to find placards posted intimating that certain spots may be used as

"free tips for refuse," and still more discreditable is it that in course of time this placard should be replaced by a notice to the effect that "this eligible site" is for sale for building purposes. The danger to health that occupiers of houses built on such sites, possibly by the jerry builder, are exposed to must be very great. Disposal of refuse by fire is the only safe proceeding, and the apparatus now available for the purpose, of which there are several types in the market, enables this to be accomplished with little or no nuisance, and at small cost. It is important also to remember that the people themselves may render great assistance to the authority by burning the house refuse, as far as possible, by means of the kitchen fire, in place of consigning it to the dust-bin, a fact which ought to be impressed upon them whenever opportunity offers.

Destruction by burning is the only safe and efficient method. This is conducted in large furnaces, constructed so that the refuse may be thrown in at the top, and the indestructible, mineral part of it (clinker), removed at the bottom. When once the fire is well started, it is found that the organic matter, of which all town refuse is largely composed, suffices to maintain the fire until complete destruction is effected, and nothing but the non-injurious mineral portion remains. The heat thus generated may be utilised for a variety of purposes; for example, the production of steam-jets in connection with the flues for increasing the draught; the pumping of sewage on to land, when the level of the surface necessitates doing so; the generation of steam for the purpose of treating the excretal refuse, when the Rochdale system is in operation; as a power for generating electricity, for lighting or other purposes; for the generation of steam necessary for the disinfection of clothing and bedding; in fact, for any purpose for which steam-power is required.

The clinker may be used for the manufacture of cement, or as a foundation for roads, for which it answers admirably

CHAPTER VIII.

HOUSE CONSTRUCTION.

Many important details relating to house construction have already been dealt with in the previous chapters; the building itself and its site have now to be considered.

Building-Sites.

The site for a house is often selected without regard to its suitability from a health point of view. Speculative builders naturally take no interest in the question, landowners are only too anxious to avail themselves of the extra price offered for building-sites, and, as a rule, the public either under-estimate or are ignorant of the important influence that locality and soil have on health.

The important considerations in selecting a site are—*dryness*, *warmth*, *light*, and *air*, and, as a rule, dryness and warmth go together, as do light and air.

The dryness of a site is mainly dependent upon the facility with which rain can pass off or through the soil, and the distance from the surface of the subsoil water (see p. 16). It follows, therefore, that flat and non-porous land, or land which, though porous, has an impervious stratum immediately underneath, is not desirable as a building-site. *A gravelly soil*, of considerable depth, and on a slight slope, is probably the best site that can be selected from this point of view, for not only does it afford facilities for natural drainage, but, by reason of its depth, the subsoil water is a long way from the surface. On the other hand, although the surface be of sand or gravel, if within a few feet there is a bed of clay, the pervious upper layer simply acts as a sponge, and absorbs the water which lies on the impervious bed immediately underneath; such a site, therefore, is not a favourable one, although it may be much improved by subsoil drainage.

Impermeable rocks, as regards dryness, are healthy, as the water readily runs off them, but in country districts the diffi-

culty of obtaining water in many cases militates against such sites.

Chalk soil is dry and healthy; so is **sandstone,** provided (for the reason given in the case of gravel) it is of considerable depth and uninterrupted by clay.

Clay and **marl,** but especially the former, are damp, and unless thoroughly drained are not desirable for building-sites.

The connection between damp surroundings and phthisis has already been referred to (p. 3), and it is probable that the prevalence of other lung diseases, as well as rheumatism, neuralgia, and throat affections, is influenced by damp.

Peat land, and all soils which contain much vegetable or animal matter, are unhealthy.

Made soils ought to be shunned, owing to the amount of organic matter they are likely to contain, which will exist in a state of putrefaction for years, and render the air surrounding the house impure.

The ground air—that is, the air which is intermixed with the soil from its surface down to the level of the subsoil or ground water—is continually being discharged into the atmosphere, owing, among other causes, to its displacement by the rainfall. This is the reason why it is important that the soil on which houses are built should, as far as possible, be free from vegetable and animal matter. To the presence of such decaying matter certain diseases are attributed; hence the importance of guarding against any risk of pollution of the ground surrounding houses as well as their actual sites.

The warmth of a site, other things being equal, is influenced by the nature of the soil and the degree of moisture it contains.

The power of absorbing heat differs in different soils, as has been proved by Schübler, who has estimated it as follows, assuming 100 as the standard:—

Sand with some lime,	100·0
Pure sand,	95·6
Light clay,	76·9
Gypsum,	72·2
Heavy clay,	71·1
Clayey earth,	68·4
Pure clay,	66·7
Fine chalk,	61·8
Humus,	49·0

These figures indicate how greatly superior the absorbing power of sand is as compared with clay, and, consequently, how

much warmer it is as a site. Again, the evaporation from the surface (see p. 14) is greater the damper it is, and as loss of heat results from evaporation, consequently a damp site is colder than a dry one.

It follows from what has been said that, in selecting a site for a house, preference must be given to one which is dry, and if there is no alternative to building on a damp site, it is imperative that it should first be drained. Attention should be paid to encouraging the natural drainage, by removing obstructions that may exist to the free flow of the streams in the neighbourhood, and thus lowering the subsoil water. The measures to be adopted against damp as regards the building itself will be considered later.

The two important requirements, *light* and *air*, are to be secured, as regards the first, by selecting a southerly or south-westerly aspect, and as regards the second, a site well removed from other buildings, and not closely surrounded by trees. It is not always possible in towns to obtain the advantages in this respect afforded by the country, but the more breathing space that can be provided the better, and to insure attention to this, all urban authorities should adopt bye-laws defining the limits beyond which buildings shall not extend (see Appendix).

Building Materials.

Bricks of good quality should be heavy and hard, and when knocked one against the other, they ought to give a clear, ringing sound. Soft bricks are more absorbent than hard ones, consequently walls built of the former are more likely to be damp and cold. Frost also has a crumbling effect upon them. The usual size of bricks is 9 inches in length, by $4\frac{1}{2}$ inches in width, and 3 inches in thickness.

The quality of bricks, as of other materials used in house building, varies, and upon it depends, in a great measure, the health and comfort of the inmates. In certain districts the clay is peculiarly well suited for brick-making, and there the chance of bad bricks being used is much less than in other districts, where, owing to the quality of the clay, the "tempering" process entails greater labour. An important part in the process of brick-making is the burning. The heat has to be raised gradually up to a certain point, at which it should be maintained, without variation, for several days and nights; should the heat

be too great, the bricks will be vitrified, and if not sufficient, they will turn out soft and friable.

It may seem strange, but it is none the less true, that wind can pass through a brick wall. This may have its advantages if we consider how rarely any provision is made for ventilation in the houses of the poor; but, as porosity is the cause, and as water can penetrate where air can, the necessity for constructing as far as possible impervious walls becomes apparent.

The quality of **stone** for building purposes varies, and hardness and compactness, or non-porosity, are the important requisites. Granite, of course, is well adapted for the purpose, but it is not met with in all neighbourhoods, and the labour involved in dressing it adds greatly to the cost of the building. The atmosphere of large towns has a perishing effect on some stones (those, for example, containing lime and magnesia), owing to the solvent action of rain and moisture when charged with gases which act chemically on stone.

Builders often use stone of the most inferior nature for window-sills, and for decorative purposes; it imparts an air of grandeur to buildings, but, owing to its perishable nature, the effect is but temporary. It is important that the builder should lay the stone as it was in its natural bed, otherwise it is more likely to perish.

Mortar is composed of sand and slaked lime, in the proportion usually of three of the former to one of the latter. The sand should be clean, sharp, tolerably fine, and free from small stones. Builders are apt to be very careless with regard to the freedom from dirt in the sand they use. Should it contain clay, marl, or earthy matter the mortar will not "set," but crumble to pieces; for this reason, it is advisable to wash all sand used for the purpose that is likely to contain any foreign matter.

The quantity of mortar used should not exceed what is necessary for insuring adhesion and uniformity of pressure. Walls built with inferior mortar, especially if a large quantity is used, are extremely friable structures, and they are far more porous than those put together with proper material.

Mortar ought to be prepared in small quantities as it is wanted, the sand being added immediately after the lime has been slaked. If it is allowed to stand it absorbs carbonic acid from the atmosphere, and when again disturbed for the purpose of being used it will have lost much of its adhesive quality.

Portland cement is the material best suited for building work in which strength is necessary.

Plaster which is applied to the interior of walls, and is used in the construction of ceilings, is prepared in a variety of ways, lime or cement being the chief ingredient. Durability, smoothness of surface, and absence of porosity, are the features of a good plaster. Unless it is smooth it is difficult to clean, and if porous it absorbs organic impurities from the atmosphere of the room, and in time becomes saturated with such impurity. Very inferior plaster is often used by speculative builders, consisting of a mixture of lime and sifted vegetable mould; such a plaster is exceedingly liable to break, for example, when articles of furniture are pushed against the wall. If the walls are papered a certain amount of support is afforded to the plaster, but in re-papering, when an attempt is made to remove the old paper the surface is certain to be more or less injured. It may here be remarked that the common practice of re-papering walls on the top of old and filthy papers is most objectionable, and ought never to be followed.

Plaster ought to be applied in three layers. The first, consisting of equal parts of lime and sand mixed with ox-hairs, is applied on the face of the wall or on laths. The second, or floating coat, is composed of slaked lime and a little hair, mixed to the consistency of thick cream. The final coat consists of a thinner mixture of lime and water, sometimes with the addition of a little plaster of Paris to facilitate setting.

Keen's cement, Martin's cement, and **Parian cement** are all mixtures of calcined gypsum and other substances; they all set hard, and are capable of receiving a high polish.

Concrete is a mixture of lime or cement and gravel from which the fine sand has been separated. Stone crushed into sharp fragments, broken pottery, and slag answer the purpose, however, better than gravel, which, owing to the smoothness of its particles, has less adhesive properties. Concrete is used for foundations, for floors, or even for the walls themselves. It ought to be made with cement when strength is of importance.

Slate is an altered form of fine clay which has been compressed and hardened by natural processes. Its laminated formation allows of its being easily split into thin sections; hence it is frequently used for roof covering.

Tiles are formed of baked clay, and are either flat (*plain tiles*), or bent (*pan tiles*). The latter are twice bent—that is, in cross sections they present both a convex and a concave surface, to allow of their overlapping laterally.

Lead is the most suitable material for covering flat roofs and

gutters, because it is very durable and can easily be worked. It is also used to form a union between the brickwork and slates (flashings), and is much to be preferred to cement for this purpose, although the latter is often used for economical reasons, with the result that the wet penetrates.

Zinc may be used for the same purposes, and very often is so used on account of its comparative cheapness, but it is much inferior to lead.

Thatch, as a roof covering, is a good non-conductor of heat, and is, therefore, both cool in summer and warm in winter, but there are objections to it from a sanitary point of view. Being of a vegetable nature, it is liable to decay, and it harbours insects and dirt.

So much for the materials used in building. The details of construction, so far as they are important from a health point of view, have now to be considered.

The foundations are of great importance, although, as a rule, too little attention is paid to them. In this case, as in the case of all work that is covered over, the speculative builder who has no conscience, has a splendid field for scamping his work, and becoming rich at the expense of the unfortunate purchaser of the property.

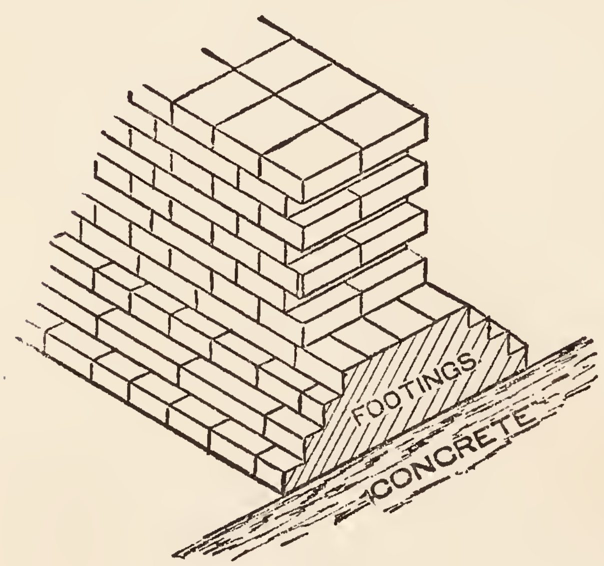


Fig. 96

It is essential in all cases, except where the ground consists of rock or other solid material, to lay a foundation of good concrete, as a base for the wall footings. Unless this precaution is observed, buildings erected on loose soils are liable to subsidence which causes cracking of the walls. The depth of concrete for this purpose is regulated in accordance with the weight of the wall which has to be supported, but in no case ought it to be less than 18 inches. In width, it ought to extend at least 6 inches beyond the footings. The height of the footings themselves should correspond to at least two-thirds the thickness of the wall above them, and they ought to project on either side for a distance equal to at least one-half the thickness of the wall (Fig. 96).

Damp-proof Course.—Unless precautions are taken to impose

a barrier to its upward progress, the moisture which is readily absorbed by the wall from the soil in contact with it, will rise, by capillary attraction, even as far as the upper rooms, and besides damaging the wall papers, will render the house damp and unhealthy. This is the most frequent cause of damp houses, and it is one that cannot well be remedied, except at considerable cost, when once the house is built, although it is easy to prevent it in the first instance. This is accomplished by placing a damp-proof course in the wall, a little above the level of the ground. Various materials are used for this purpose, such as sheet lead, or a layer of asphalt $\frac{3}{4}$ inch thick. Slabs of glazed stoneware are specially manufactured for the purpose. They are perforated longitudinally, and thus serve another useful and necessary purpose, in allowing a current of air to pass freely under the flooring. These slabs are made in different widths, to suit walls of various thickness (Fig. 97). Slate imbedded in cement is often used, but this is not satisfactory as the wall in settling may cause fracture.

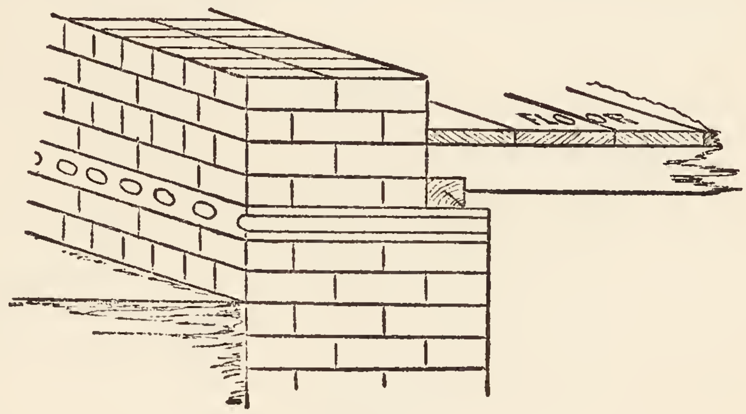


Fig. 97.

The above arrangement of damp-proof course is applicable in the case of a house without a basement storey, the flooring of which is above the ground level; it is obvious, however, that it would not answer the purpose in the case of a house with a basement, or one with the ground floor on a lower level than the surface. Under these circumstances, it is necessary to construct an area round the house, or a substitute for it, the bottom of which is below the level of the basement floor, so as to allow of a damp-proof course being inserted between the floor and the bottom of the area, in the manner just described. The construction of an area, however, is expensive, and not always practicable, but the same object may be attained, at less cost, by forming what is termed a **dry area** (Fig. 98). This practically corresponds with an ordinary area, except that it is covered, and is only sufficiently wide to keep the damp earth from touching the wall. Another plan (Fig. 99) that answers very well, is to build that portion of the wall which is below the ground level

hollow, and in this case it is necessary to insert two damp-proof courses, the one extending across the wall below the basement floor, and the other across the wall a little above the ground level. The accompanying sketches will assist in making the above description clear.

No matter which plan is adopted, it is necessary to provide drainage from the bottom of the area or cavity, and, both in the case of the dry area and the hollow wall, ample openings must be provided for ventilation. For this reason, in order to avoid a space in which dirt may accumulate, a better plan is to fill the cavity with asphalt, which would entirely prevent the penetration of damp.

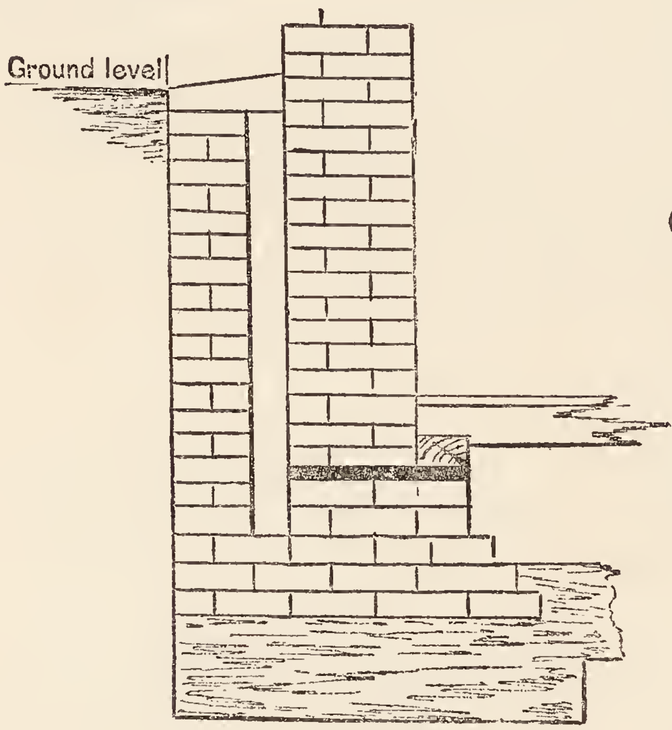


Fig. 98.

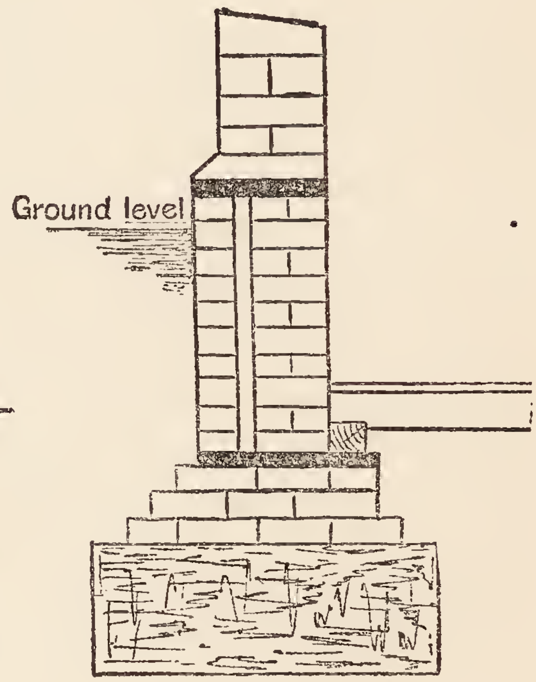


Fig. 99.

Impervious walls above the ground level are also of importance, otherwise driving rain will penetrate into them, especially in the case of houses in exposed situations, and during long periods of rain.

Walls may be rendered practically waterproof by coating them with good Portland cement. Slates or tiles fastened to battens on the face of the wall, will also answer the purpose, although the former are unsightly, as indeed are the latter, unless in the original design it was intended to construct tiled walls. "Rough-casting," which consists of a coating of good mortar, on which shingle and small pieces of flint are sprinkled, answers the purpose when the work is well done, and it does not necessarily detract from the appearance of the house. Pitch or paint, if regularly

renewed, will also protect the walls from damp, but both are unsightly, and the latter is costly.

Various plans are adopted for rendering the walls of houses impervious to wet in the first instance.

Cavity-walls are designed for this purpose; they are practically double walls, with a space of 2 or 3 inches between them, and these are tied together at intervals by bonding-ties of non-absorbent material, such as iron or glazed stoneware. In order to insure stability, the distance between each tie ought not to be greater than 3 feet horizontally, and 18 inches vertically, and if iron is the material used, it ought either to be galvanised, or coated with some other protective material, to prevent rusting. These walls, in addition to being impervious to wet, are bad conductors of heat; consequently, in houses so constructed, a uniform temperature is more easily maintained than in those built with solid walls of equal thickness. It is essential that ample means for the ventilation of the cavity should be provided.

Asphalt is sometimes used to fill up cavity-walls as a protection against damp, and, as already stated, it answers the purpose very well; in this case the space between the inner and outer wall need only be a narrow one.

There are other causes of damp walls besides those already mentioned. Damp may penetrate from the top, where **parapet walls** are unprotected. These may be protected in a variety of ways. The top line of bricks may be laid in cement upon a line of tiles, which project from the side to prevent rain from trickling down; or a sloping covering, consisting of slabs of stone, with the lower margins overhanging the sides, may be fixed along the top of the parapet. Another weak point is where the roof joins a parapet wall. The common method adopted in this case to prevent wet from entering the building is by cement flashings, but, sooner or later, the cement will separate from the brickwork, and cause leakage; lead flashings are much to be preferred (see p. 192). The lead is inserted in the joints of the brickwork, and, passing across the angle formed by the wall and the roof, is continued along the latter for a little distance.

Window-sills also cause damp unless they are built beyond the face of the wall and are grooved longitudinally (*throated*) on the under projecting surface. Again, a very common and serious cause of damp walls is **defective spouting.**

It is by no means uncommon, especially in the country and in small towns, to find houses entirely devoid of spouting. The evil arising from this is most serious, as any one who will take

the trouble to look at the internal surface of the walls can discover for himself. It will also be found that along the base of the walls, unless the ground is paved, a gutter has been formed by the constant drip of the rain from the roof, and during the actual rainfall, this gutter will contain water, which is absorbed by the walls, within which it may rise to a considerable height.

From what has been said concerning the danger to health arising from damp surroundings, it will be understood that it is the duty of authorities to insist upon all houses being spouted—a duty which is far too often disregarded. While recently inspecting a district in Staffordshire, the author met with a most striking example of the evil effects that had followed as the direct result of an important sanitary improvement. The greater portion of the district in question had been provided with a good and plentiful supply of water by a neighbouring company. The company's plant did not allow of the water being carried to one portion of the district, which was situated on a considerably higher level than the rest. The result was that, from the moment of the introduction of the water, the rain-spouts of the lower part of the district were allowed to decay, until little vestige of them was left, while the houses on the higher part were fairly well provided with spouts. The fact was, in the one case, the introduction of the water-supply rendered it unnecessary to conserve the rainfall, consequently it was allowed to take what course it liked; while in the other case, the absence of a water-supply rendered rain storage—and therefore spouting—necessary.

Defective "pointing," owing to the mortar between the bricks having perished and crumbled away, is another frequent cause of dampness. It is of the utmost importance, therefore, that all walls should be kept in proper repair in this respect by being repointed from time to time as occasion arises. In this case undoubtedly a stitch in time saves nine.

Thickness and Structure of Walls.—No house with one or two storeys ought to be built with walls of less thickness than 9 inches, and a 14-inch wall is much to be preferred; indeed, unless the building material is good, and the precautions against weather already described are taken, the latter thickness will not afford sufficient protection. If built of brick, the bricks ought to be properly bonded together, by being laid length-ways and cross-ways alternately, and only whole bricks should be used. This is important from the point of view of stability, as if broken bricks, or "bats" as they are called, are used, the wall

is greatly weakened. When, from any cause, the foundations are at all doubtful, or if special strength is desired without increasing the thickness of the wall, **hoop-iron bonds** may be introduced.

The Roof.—The comfort of the householder is as much dependent upon the soundness of the roof as upon the goodness of the walls and foundations. Unless the material and workmanship are good, constant annoyance will be experienced from leakage, and, in addition to this, the temperature of the house is greatly influenced by the nature of its covering.

As already mentioned, roofs are generally covered with slates or tiles; in some localities, however, where suitable stone is available, thin slabs of it are used; stone, however, is objectionable, on account of its weight. For flat and dome-shaped roofs, lead, zinc, and even copper are used, or, in the case of flat roofs, asphalt or reinforced concrete. The inclination a roof ought to have is dependent upon the material used. If the material be metal, the slope need not be greater than will suffice for the rain to flow off into the gutters, and if slates or tiles are used, the necessary inclination depends, to some extent, upon their size and porosity. Large slates require less inclination than small ones. Stone slabs and tiles, being more porous than slates, ought to have a greater slope. The following figures indicate the inclination that is recommended in each case, and it is important that the specified inclinations should be adhered to.

Ordinary slates need	an inclination	of about	26° to 30°	with the	horizon.
Stone slabs and tiles	,,	,,	45° to 50°	,,	,,
Thatch needs	,,	,,	55° to 60°	,,	,,

Slate varies very much in quality. For roofing purposes, it ought to be hard, non-absorbent, of fine quality, and free from veins or streaks. If veins are present, the slate in time will split, and unless it is hard it will break, or the nail-holes will gradually enlarge, and ultimately the slate will fall off.

Slates are often laid on laths, but the practice is not a good one; boarding is far better suited for the purpose, as it forms a solid base, and offers a greater resistance to changes in temperature. If laths are used it is necessary to point the under side of the slates with hair mortar ("torching") in order to prevent the wide from blowing through, carrying with it rain or snow, as well as to steady the slates and keep them from rattling. It is an excellent practice to cover the boarding with felt before the slates are fixed; such an arrangement greatly conduces to the

warmth of the house in winter, and its coolness in summer. Slating should be laid with a **3-inch lap,** otherwise the rain or snow will be driven through. This requires a little explanation, which the accompanying sketch (Fig. 100) will make plain. By a 3-inch lap is meant, not simply that the lower edge of one slate should cover the top edge of the one immediately below it to that extent, but that it should overlap the next slate but one below it for 3 inches.

The nails used for fixing slates (two for each) ought to be made of copper or zinc, or a mixture of copper and tin; the first metal is best for the purpose, although composition nails and zinc nails answer very well. Iron nails ought never to be used

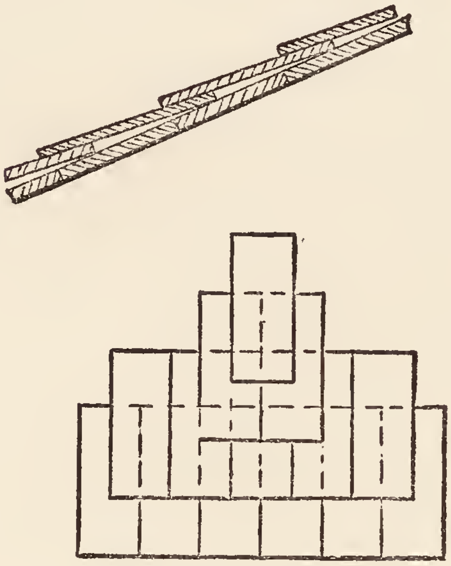


Fig. 100.

Fig. 101.

Fig. 102.

as they rust, and ultimately break. Tiles are fastened by **oak pins.**

As already stated, **lead** is the material to be preferred as a covering for flat roofs, and **milled lead**—that is, lead that has been rolled out into sheets of uniform thickness—is the best. The thickness of the lead used will depend upon whether there is a likelihood of the roof being walked upon to any extent, and if there is not 5 or even 4 pounds to the superficial foot will answer the purpose, although in some cases it may be necessary to use a thickness equal to 7 pounds.

In jointing the lead, it is important to remember that the metal expands by heat, so if seamed-joints are made, no play will be allowed for this expansion, and puckering, followed in time by splitting, will take place. To avoid this, it is best to unite the lead, by overlapping the edges over a wooden roll, in the manner shown in the sketch (Fig. 101).

As far as possible the use of nails must be avoided in all lead work, because of the galvanic action that takes place between the two metals leading to decay, and consequent leakage.

Zinc has certain advantages over lead, but these are far outweighed by its disadvantages, although, as now manufactured, it is admissible if proper care is observed in laying it. The advantages are its lightness and comparative cheapness; on the other hand, it is less durable, and more troublesome to fix. An angular roll (Fig. 102) is better suited for zinc than a circular one.

With regard to the interior of the house, most points of importance have been dealt with in the chapters devoted to house drainage, but the construction of the floors has yet to be considered.

It is of the utmost importance that the **cellar** and **basement floors** should be laid so as to be absolutely impervious to ground air. The significance of this, from a health point of view, has already been noticed, and it is impossible to over-estimate it. The damp and disagreeable odour that rises from cellars is well known to every one, yet, even in modern buildings, precautions are seldom taken to correct the evil. Cellar floors are usually formed of bricks set on the ground itself, without even a bed of mortar being interposed, and thus but little opposition is offered to the entrance of unwholesome effluvia, which are attracted by the warmth of the house, from an area considerably larger than that upon which it stands.

That this happens there is ample proof in the penetration of gas from leaking street mains, especially during a continued frost, when the ground outside the house is more or less hermetically sealed, and the cellars are the only vents. If, then, ordinary gas can find its way into houses, why not sewer gas from pervious sewers and cesspools as well as the ground air, it may be, from a made site formed of decaying vegetable and animal matter?

The following striking example of the danger arising from pervious cellars occurred in the author's experience, and was attended with serious consequences.

In Darlaston, a mining town in South Staffordshire, a whole family, including the father, mother, and three children, were found one morning early in January, 1891, in bed, on the first floor of a small cottage, in a comatose condition. From this state it was impossible to rouse them, and unconsciousness lasted from twelve to twenty-four hours. The medical man in attendance at first could not account for the symptoms, and the condition of

the patients was so serious, that he remained in the house for three hours. At the end of this time, he, as well as friends of the family who were assisting, began to suffer from severe headache and lassitude, and then it was decided to remove the patients to another house, as it was suspected that the symptoms were in some way associated with the surroundings of the cottage. The opinion that the illness was owing to some atmospherical cause, was ultimately strengthened by the discovery that two canaries and a cat had died during the night in the kitchen of the cottage, the former in a cage, and the latter in a cupboard, the door of which was open. The same morning, also, in a house on the opposite side of the road, the occupants of which had, for some time, suffered from headaches and depression, two birds were found dead in their cage in the kitchen. It is important to notice that all the animals died in the respective kitchens of the houses —and, therefore, on the ground floor—while the families slept on the first floor, a circumstance to which, in all probability, they owed their escape from death.

Enquiry afterwards elicited that the family in question, as well as at least two other families in adjoining houses, had suffered from headache, etc., more or less persistently for three weeks, a period which corresponds exactly with the existence of a fire in a disused mine, the workings of which were within 60 feet of the surface.

It was afterwards proved by analysis that poisonous air, containing carbonic oxide gas (see p. 73), the result of the combustion under ground, was being discharged into the houses through the pervious cellar floors; this gas, combined no doubt with carbonic acid gas, was the undoubted cause of the illness.

It is interesting to notice, that for several weeks previous to the occurrence, the surface of the ground had been covered with snow, and frozen to a considerable depth; had this not been the case, possibly the illness would not have occurred, at any rate in such a severe form.

Such an occurrence as that just related is, happily, rare, but it possesses an interest to health officers in the lesson that it teaches as to the importance of so constructing cellars of houses, that they shall be impervious to ground air.*

* For a full account of the above occurrence, see a paper by the author in *Public Health* for April, 1891.

Strange to say, the author has since met with another similar occurrence, also during frost and snow, in which several persons suffered, one person who slept on the ground floor being found dead as well as many birds.

To render a cellar dry and impervious to ground air, it is necessary to cover the floor with a non-porous material, but unless a dry area or other contrivance has been provided, this alone will not suffice.

Concrete or asphalt, or both combined, is the most suitable material for cellar floors. It is a mistake to suppose that concrete, as it is commonly laid, is impervious ; in order to be so, it must be well rammed down and laid 6 inches deep, the surface should then be well grouted with liquid cement, and afterwards floated with a smooth surface of cement. Nothing more need be done, as this will form an excellent floor, but, if it is preferred, a surface of asphalt may be laid on the top, or it may be bricked over, or stone flagging may be laid down. It is necessary to provide for ventilation, by fixing air-openings under the ceiling on opposite sides.

Such a floor as this will answer very well for the ground floor of houses without cellars, as it is smooth, cleanly, and free from any cracks that will harbour dust. If, however, wood flooring is desired, it should be laid on joists on a similar bed of concrete, free ventilation being provided for underneath, either by means of ordinary air-bricks, or openings covered with iron-gratings, or by the perforated glazed slabs already described (p. 187).

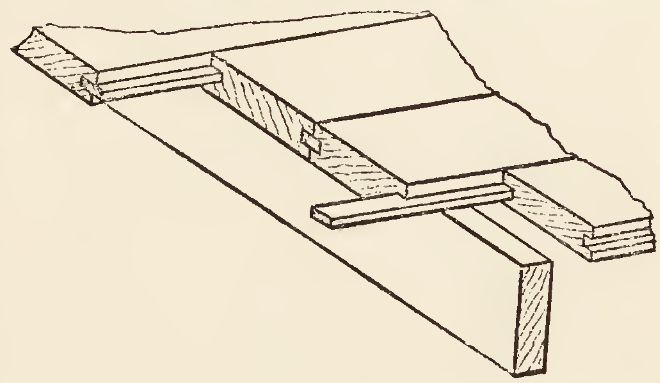


Fig. 103.

Ordinary wood flooring in kitchens is conducive to black beetles, but what is known as a **wood-brick floor,** by reason of its solid construction, does not favour such vermin, and is warmer than bricks or tiles. These wood-bricks, which are generally 10 inches long by 3 inches wide, and from $\frac{3}{4}$ to $1\frac{1}{2}$ inch thick, are laid in a mixture of tar and asphalt, on a bed of concrete. Such a floor is noiseless, durable, and cleanly. Wood-brick floors are sometimes laid with the end grain of the wood upwards, but they are not so easily cleaned, and they stain more readily.

It is unnecessary to describe in detail the various kinds of wood flooring (fancy and otherwise) for upper rooms, but a few points, of importance in a sanitary sense, may be mentioned.

In the first place, it is essential that seasoned wood only

should be used, otherwise spaces will very soon be formed between the boards, through which dust will fall into the space between the floor and the ceiling below. It would astonish most people to see the amount of filth that does so collect. To avoid this, one or other of the various plans for uniting the edges of the boards should be adopted, and the most usual is what is known as the **ploughed and tongued floor** (see Fig. 103). Both edges of the boards are grooved, so as to receive strips or tongues of wood or iron, the groove being deep enough to receive one-half the width of the strip, so that, when the abutting board is pushed home, an equal width of strip is embraced by both. If iron is used, it ought to be galvanised to protect it from decay. The joints between the ends of the timber are usually made by simply adjusting the two flat ends together, but it is better, in inexpensive work, to splay the ends, so that the one slightly overlaps the other. These joints ought invariably to correspond with the joists, and contiguous boards ought not to be jointed over the same joist.

Double joists, the upper lot for the floor, and the lower for the ceiling-laths of the room below, are much to be preferred to single joists only with ceiling-laths. They afford a firmer surface for the plaster, which, in consequence, does not crack so readily, and sound is less easily carried from one room to the other.

Wall-papers.—Mention has already been made of the most suitable material for lining walls, the great object to be attained being smoothness of surface, and non-porosity; the decorative part of the work has now to be considered, in so far as it relates to health.

A wall-paper ought to have a smooth surface, so that dust may not collect on it, although certain stamped papers that have an uneven surface are easily cleansed. The worst dirt collectors are flock papers. Most papers, unfortunately, absorb moisture, but the worst in this respect are the so-called satin papers. Washing papers are now manufactured, and some of these, for example, that known as "Muraline," certainly do permit of being washed without injury to the colour.

The most important consideration, however, in selecting papers, is to avoid those that contain **arsenic**. Although this danger is now pretty generally recognised, it is too often disregarded, notwithstanding the fact that papers in all colours can be had free from it, indeed the best makers no longer use arsenic. It is popularly supposed that green is the only dangerous colour, and that the sole precaution necessary is to avoid it;

this is an absolute fallacy, for other coloured papers may contain arsenic.

The medicinal dose of arsenic varies from $\frac{1}{60}$ to $\frac{1}{12}$ grain, and when one considers that wall-papers have been found to contain as much as 17 grains per square foot, the gravity of the question becomes apparent. The danger attending the use of arsenical wall-papers arises from the substance being inhaled, either as dust particles, or in the form of a gas—namely, *arseniuretted hydrogen*, and the risk of both occurrences is increased by the methods adopted in the preparation of the paper. Size is used for the purpose of retaining the colour, and when it dries it has a tendency to crack and peel off, carrying with it particles of colouring matter, which are thus disseminated throughout the air of the room. It would appear also that size, in combination with arsenical compounds, has the power of liberating the highly poisonous gas already mentioned, which, owing to its ready absorption by the lungs, is the most fatal form in which the poison is met with.

There is no simple test by which the public can ascertain the presence of arsenic in wall-paper, so that the only safeguard is to deal only with reliable firms, and if there is any reason to doubt their honesty, it is well to ask for a guarantee with regard to the purity of the paper, which may afterwards be verified by the certificate of an analyst. It may be mentioned in passing, although it does not come within the scope of this work, that certain articles of clothing—muslin for example—as well as artificial flowers, and toys, may give rise to arsenical poisoning.

Re-Papering of Walls.—Before re-papering a room the old paper ought to be completely removed, and the walls should be thoroughly cleansed. This is a practice which is by no means invariably followed, although a moment's thought will convince one of its importance. Layer after layer of paper is applied, one above the other, by means of paste composed of organic matter, and the result of this is that decomposition, which is encouraged by the moisture and heat of occupied rooms (see p. 79), ultimately takes place, and unwholesome smells are given off.

In concluding this chapter on house construction, it may be laid down as a general axiom, as regards the interior, that angles and projections should be avoided as far as possible, especially in situations beyond convenient reach, as they encourage the accumulation of dust and dirt. This caution applies equally to articles of furniture, such as wardrobes, projecting cupboards,

and bookcases, the tops of which, in place of being perfectly flat, have usually false cornices attached for the sake of appearance, forming deep receptacles in which the dust of ages collects. In the case of new houses, it is becoming customary to construct such articles of furniture as fixtures in the walls, a practice which economises space, and obviates the nuisance referred to.

To facilitate cleansing, it is also desirable that all floor coverings should be easily removed. **Carpets** ought not to extend over the whole floor, as they will then seldom be taken up, owing to the labour involved in moving heavy side pieces of furniture. Thus dirt will collect within the texture of the material, and be scattered throughout the air of the room by persons walking about. In bedrooms especially the less floor covering there is the better.

Unless under exceptional circumstances, wooden floors should not be washed, as damp is thus diffused throughout the room. This is especially important in the case of hospital floors. Polishing with beeswax is a far better proceeding, and it renders the floor almost non-absorbent.

CHAPTER IX.

INFECTION AND DISINFECTION.

THE subject to which this chapter is devoted is one which ought to engage the serious attention of the Sanitary Inspector and the public generally. It is one concerning which the grossest ignorance prevails, at the cost of a large amount of needless suffering and death. The royal president of the 1891 International Congress of Hygiene and Demography, in alluding in his inaugural address to the class of diseases known as **preventable,** asked the question, "If preventable, why not prevented?" In reply, it may be said that apathy and ignorance on the part of the public are mainly responsible, and until the people wake up to the fact that without their assistance the efforts of sanitarians to stamp out contagion must be largely inoperative, little advance can be made.

In order to appreciate the importance of the precautionary measures which are recommended for the purpose of preventing or limiting the spread of infectious disease, it is necessary in the first place to consider what the nature of the infective agents is, and by what channels they enter the body. There are few subjects more interesting, none more important to the sanitarian, than investigations into the nature of that something, outside and apart from our bodies, to which we owe the existence of infectious disease. Modern research in this direction has thrown considerable light on what formerly was wrapt in obscurity, and although much yet remains to be discovered, what has already been accomplished has exposed many fallacies and brought many changes in the old methods of prevention.

Bacteriological research has revolutionised preventive medicine, and the "germ theory of disease" may now be said to have been proved. As the discovery of the cause of disease is the first step towards the remedy, the more accurate our knowledge, the more active must our efforts be to make use of it.

Thus, as new dangers to health are exposed, legislation has to keep pace with advancing knowledge. For example, the growth of knowledge regarding our food supply as a source of danger to health has led to the introduction of the Dairies, Cowsheds,

and Milkshops Order, 1885, the Infectious Diseases Prevention Act, 1890, the Tuberculosis Order, 1913, and the Milk and Dairies (Consolidation) Act, 1915, all of which have added to the responsibility of sanitary authorities. The last-mentioned Act, however, does not come into operation until so ordered by the Ministry of Health, and in no case until one year subsequent to the termination of the war.

The study of diseases of animals in relation to those of man has brought to light new dangers; for example, the possible connection between human scarlet fever and an affection of the udders of cows of a trivial nature, first exemplified in the now celebrated outbreak of that disease at Hendon, supported by evidence of similar subsequent outbreaks in many districts, as well as outbreaks of anomalous throat ailments attributed to milk from cows with udder affections. Although it cannot be said that the human and bovine ailment referred to have been proved to be directly associated, the evidence in support of that contention is very strong; at the same time, it is difficult to exclude the possibility in such cases that milk has merely been the channel of conveyance of the infection from one human being to another and that the concurrent udder affections were merely accidental.*

Although Koch, some years ago, disputed the fact that bovine and human tubercular diseases were identical, the report of the Royal Commission on Tuberculosis has once and for all settled the question, and has established the fact that the disease may be introduced into the system by cow's milk and butcher's meat. This, however, will receive attention later.†

Again, as regards the channels by which the contagion of diphtheria may gain admission, the opinion that domestic animals are in some cases responsible has, during the past few years, been gaining ground. In 1888, Dr. Bruce Low, in a report to the Local Government Board on an epidemic of this disease which occurred at Enfield, mentioned an instance in which a cat seems to have communicated the infection. It appears that a child, who died from the disease, had vomited on to the floor on the first day of illness, and a cat was seen to lick the vomit. In the course of a day or two (and after the boy had

* This question is very fully discussed in a paper read before the Epidemiological Section of the Royal Society of Medicine by Dr. W. G. Savage, published in the *Proceedings* of that Society (Vol. iv. No 5), March, 1911.

† *Final Report of the Royal Commission on Tuberculosis*, 1911.

died) the cat was found to be suffering severely from symptoms very similar to those noticed in the case of the boy, so much so that the owner destroyed it. Early in its illness this cat was let out into the back yard, and a few days later a cat belonging to a neighbour, which had also been in the yard, was found to be suffering in the same way. The second cat, during its illness, was constantly nursed by four little girls, all of whom developed diphtheria, and, apart from this, no other source of infection to which they had been exposed could be traced.

As more recent examples of the dangers man has to fear from animals, may be mentioned the part played by rats in conveying plague, and by a certain species of mosquito as the carrier of the poison of malarial fever.

Although, no doubt, in time further evidence will be forthcoming to add to the dangers we have to fear from animals in this respect, in the case of most infectious diseases the usual cause of infection is personal communication, either direct or indirect. This will be dealt with in discussing the preventive measures appropriate to each disease.

The belief, then, that all infectious diseases are associated with minute **living germs** (*micro-organisms*) is now generally accepted; in fact, in the case of several diseases the connection has been conclusively demonstrated.

These germs possess an independent existence, and, when introduced into the body, have the power of multiplying enormously. Whether they are the direct cause of the diseases with which they are associated, or whether the cause is to be attributed to morbific materials to which they give rise, is still an open question, but this does not affect the main fact that their presence is an essential element in the production of what are known as **specific infectious diseases.** Neither does it matter, for our present purpose, in what manner their existence within the body gives rise to the manifestations peculiar to each form of disease.

In order to combat the diseases of the infectious class, it is necessary to know the habits and understand the requirements of the organisms which give rise to them, and as filth, in its broad sense—foul air, foul water, and foul surroundings—is the chief essential to their existence, cleanliness is the weapon to be used against them. That filth and disease go hand in hand has long been recognised; it is the discovery of the reason that is of recent date. The old argument—still often used—that certain insanitary conditions, to which any outbreak of disease is attri-

buted, had long existed without serious consequences, can now be answered as follows :—" True, but the one element necessary —the specific germ—was not present, although everything was ready for its reception; it might have come and gone had it not been so well received, and no one need have been conscious of its presence." Although, then, to the naked eye the actual organism of disease is not visible, the conditions upon which its growth and development depend are, and it is to these that our attention must be directed in order successfully to prevent the ravages of the invisible foe. Given a perfect state of cleanliness, in the broadest sense of the term, most diseases of the contagious class would become things of the past. Until this state of perfection is reached (should this ever happen), we must be prepared with the means of destroying contagion when it is met with.

Behaviour of Contagion within the Body

After the introduction of the contagion into the body, by whatever channel, some time elapses before the disease manifests itself; this is termed the **period of incubation,** and it varies in different diseases from, it may be, a few hours to several weeks or even longer. This fact has an important bearing in connection with the preventive measures to be adopted, and it will be referred to again when we come to consider each disease separately.

During this period the germs rapidly multiply within the body, until what is termed the **period of invasion** is reached, when symptoms peculiar to the disease in question become manifest. The severity and duration of the second period varies, although in some diseases, such as enteric fever, the duration is fairly constant, but, sooner or later, if no secondary consequences follow, and the patient survives, the disease ends in **convalescence.**

The period of greatest danger, from an infectious point of view, varies in different diseases. In measles and whooping-cough, for example, it corresponds with the early stage of the malady, in enteric and typhus fevers with the acute stage, while in the case of scarlatina, small-pox, and possibly diphtheria, the danger may be greatest in the later stages and during convalescence, although small-pox and diphtheria, if not scarlatina also, are highly contagious from the first.

SCARLET FEVER.—CASE-MORTALITY, LONDON, 1900-9.

Years of Age.	No. of Cases.	Deaths.	Mortality per Cent.
0-1	1,426	210	14·7
1-2	5,702	633	11·1
2-3	10,707	860	8·0
3-4	14,359	795	5·5
4-5	16,782	580	3·4
Total under 5	48,976	3,078	6·3
5-10	62,601	1,095	1·7
10-15	24,826	215	0·9

It must not be inferred, however, from these remarks that a relaxation in the precautionary measures adopted is justifiable during any stage of infectious disease, and it must be remembered that as stringent precautions are necessary in mild as in severe cases, for it does not follow that the type will be maintained—a serious case may owe its origin to a mild one.

The common practice of exposing children to infection, on the pretext that the ailment, whatever it may be, is mild in its nature, and that, sooner or later, they will contract the disease in any case, is greatly to be condemned. One especially hears this argument used during outbreaks of measles, whooping-cough, and scarlatina. It is, however, highly fallacious, for the following reasons :—(1) A mild case may give rise to a serious one ; (2) it by no means follows that all should suffer during some period of their existence ; (3) one attack does not necessarily afford protection from a second ; (4) the fatality in children is nearly always greater than in adults ; (5) the liability to attack diminishes with age.

DEATH-RATES PER 100,000 LIVING AT DIFFERENT AGES, 1881-1900.

	Under 5 Years.	5–10 Years.	10–15 Years.
Measles, . . .	313	27	23
Scarlet Fever, . .	167	76	15
Whooping-cough, . .	337	13	0·4
Diphtheria, . . .	69	42	10

The foregoing tables, one showing the case mortality from scarlet fever at different ages, based upon 10 years' figures for London, and the other the mortality from certain diseases per 100,000 of the population at different ages, extracted from the last decennial supplement to the Report of the Registrar-General, published in 1907, bear out the last two statements that both the fatality and liability to attack is greater among young children, and that both rapidly decline after the fifth year of life. This has an important bearing upon the question of the attendance at school of children under 5 years of age.

That children run no more risk of infection by attending school than in associating together in their homes or out of doors is a popular fallacy. Sir Arthur Newsholme, late Medical Officer of the Local Government Board, in a paper read at a meeting of the Childhood Society, in 1902, emphasises this very forcibly, in referring to the influence of school attendance upon the spread of diphtheria, as follows:—

"Contact between well and sick out of doors is less intimate and less protracted than indoors. Contact in a neighbour's house is with a few possible sources of infection; in a classroom containing the sixty children allowed by the Education Code, the contact is with a large number of possible sources of infection. To use a homely illustration, it is the difference between 'retail' and 'wholesale' infection. Similar remarks apply to measles and whooping-cough, and in a less degree to scarlet fever. Among the well-to-do classes the proportion who go through life without having suffered from any of the infectious diseases of childhood is considerable; among the classes whose children attend public elementary schools this proportion is very small. Admitting that these schools do not account for the whole of the difference, the proportion escaping in the latter would undoubtedly be greatly increased by forbidding school attendance before the sixth year of life, and many thousands of lives, now unnecessarily lost, would be saved."

General Preventive Measures.

Before discussing in detail the special preventive measures recommended and practised in the case of each disease belonging to the infectious class, it may be well to consider the general principles that ought to guide one in forming an opinion regard-

ing their efficacy under the following heads, namely—**Isolation, Quarantine,** and **Disinfection.**

Isolation of the patient, to be effective, cannot under ordinary circumstances be accomplished at home, but in large establishments it may, provided scrupulous attention is paid to certain details of management. Sometimes one does meet with thoughtful and intelligent parents, who in their anxiety to save the rest of the household from the disease, and at the same time keep the patient under their immediate care, will carry out, to the letter, all instructions regarding the requisite preventive measures; but more frequently, however anxious people may be not to err in any direction, inexperience is very apt, sooner or later, during a long and anxious illness, to lead to the neglect of some vital precaution. As a rule, the only person to be relied upon is a good nurse, who, from long training and experience, has acquired habits of caution which have become almost automatic.

Having selected rooms at the top of the house (or, better still, in a detached wing) that may be set apart for the patient and his attendants, all unnecessary articles of furniture, carpets, curtains, and bed-hangings should be removed, only such as are essential being retained in the room. The other occupants of the house must be forbidden, on any pretext whatever, to pass beyond a certain limit, and all necessaries, such as food, coal, etc., should be carried that distance and no farther.

Attention to ventilation in the sick room, by the frequent openings of windows at the top, is of the utmost importance, and a fire ought always to be kept burning, whatever the season may be, to insure that a constant current of air shall pass into the room and up the chimney, and thus limit the risk of infected air passing from the room into the house; besides, by having a fire in the room, all useless infected articles may be burned at once. No articles of clothing, or utensils, should be taken out of the room without first being disinfected, in a manner to be described presently. The persons in charge of the patient must not leave the room without first washing their hands and changing their outer clothing. It is well that the dress worn in nursing the case (which ought to be of a washable material), should be left in the sick-room, and the substitute put on in an adjoining room, which also must be looked upon as closed to the rest of the household.

The common practice of hanging sheets, moistened in supposed disinfectants, outside the door of the sick room, serves no purpose whatever, as, even allowing that the material used may be

a disinfectant, any air passing out of the room would not penetrate the sheet but pass under or round it. Vessels placed about the house, containing Condy's fluid or carbolic acid, are equally useless; both certainly act to some extent as deodorants, but by far the best deodorant is fresh air. The public have a strong faith in such measures as these, although, as will presently be explained, they have no real virtue, and on the ground that the false security they afford may encourage a less careful observance of needful precautions, their use ought to be discountenanced.

From the above account of what is essential to successful isolation, it will be apparent that the conditions cannot be fulfilled in the case of cottages and small houses.

With regard to the period during which the patient should remain isolated, that is a question which must be decided by the medical attendant, who ought to certify when the time of danger is past; it varies in different diseases, as will be pointed out later.

The structural arrangement and management of **isolation hospitals** hardly come within the scope of this little volume, but it may be well to direct attention to their utility from a public health point of view. Incidentally, of course, they are curative institutions, and as local authorities have statutory powers enabling them to enforce removal to hospital when isolation at home is found to be impracticable, it is incumbent upon them to have regard to the comfort and well-being of the patient in the provision they make. The *raison d'être* for such institutions, however, is the public safety, and if the doubts recently advanced regarding the utility of hospital isolation in certain cases should ultimately be established, the policy hitherto advocated must be considerably modified. Attempts have recently been made to discredit hospital isolation in the case of scarlet fever, and it must be admitted that the arguments adduced in support of this contention are very forcible. Still, even if hospital isolation of such cases proved to be a failure as a preventive measure under present conditions, it does not necessarily follow that the hospital is to blame, for there are other possible weak points in the defensive armour, such as delay in removal, insufficient home disinfection, and unwise aggregation in hospitals of acute and convalescent cases, which may, in part at any rate, explain the admittedly disappointing results.

Be this as it may, however, certain other infectious cases have to be provided for, in which home in preference to hospital

isolation has not yet been advocated. County Councils therefore need not, because of recent events, determine to allow the Isolation Hospital Acts to become a dead letter.

The aim of County Councils should be to frame as comprehensive schemes as are compatible with efficient and economical administration. For example, by forming large areas—possibly a whole county—with hospitals at various points, a staff of trained nurses could be established in a central position, and, as occasion required, they might be drafted off to any part of the county. The number of this staff could be regulated in accordance with the prevalence or otherwise of epidemics, but the probability is that it would be fairly constant. By such a system as this, economy would undoubtedly be effected, and there need no longer be any delay in the isolation of first cases. At present, in the case of small hospitals with no permanent staff, this delay does occur, and often leads to unnecessary extension of disease.

In addition to isolation of the patient, it is necessary, in order to secure the full benefit from such a proceeding, to impose a period of quarantine—varying in different diseases, and regulated by the duration of the incubation stage—upon all those previously in contact with him. It is obvious that unless this precaution is observed, the object aimed at, namely, the stamping out of the disease, may be defeated, for others may already have contracted it, and thus the poison may be disseminated broadcast.

Difficult as it is to secure proper isolation, the difficulty is still greater as regards quarantine. When illness occurs in a family, it is more than ever necessary that the bread-winners should be at work. This argument, however, does not apply in the case of children, who ought always to be kept from school until all danger of communicating the disease is over (see p. 209 as to exceptions). If the patient has been isolated, and the premises have been thoroughly disinfected, this period need not be prolonged beyond the full extent of the incubation period of the disease in question; but if, in the meantime, other members of the family should show symptoms of the disease, the quarantine period must start again *de novo* after the isolation or termination of the fresh cases, and the re-disinfection of the premises, etc. In certain diseases both isolation and quarantine must be enforced more rigidly than in others.

In the case of small-pox, for instance, both are of the utmost importance, whereas a case of enteric (typhoid) fever does not call for such extreme caution, indeed quarantine if not isolation may be dispensed with, provided every care is observed in dealing

with the discharges from the patient, according to the instructions which are given later on, this, however, is seldom practicable at home. In the case of people engaged in certain occupations, quarantine must be strictly enforced. For example, tailoring, dress-making, glove-making, washing, milk-selling, and people engaged in handling food or clothing.

In some towns quarantine stations are provided by the authorities, and the occupants of infected houses are granted free board and lodging until the danger of communicating the disease is past.

The question of the **closure of schools** during epidemics is one concerning which a certain amount of difference of opinion prevails, and it may conveniently be discussed at this stage as the responsibility rests with the sanitary authority, under the advice of the Medical Officer of Health, or with the education authority on the advice of the School Medical Officer.

The view held by some is, that it is a valuable measure to adopt in all cases, while others doubt whether it has been demonstrated that much good results from it. The truth probably lies between these two opinions, and no hard and fast rule can be laid down; what is applicable to densely populated towns may not apply to widely scattered rural districts, and in some cases a modified course might be the right one to adopt.

In rural districts the school is the centre of communication between families who possibly might otherwise see nothing of each other. In such cases, to allow children from distant villages—where, say, scarlet fever is prevalent—to continue to congregate daily, in a centre where they come in contact with children from other villages where the disease does not exist, would be a rash and dangerous proceeding; but it does not follow from this that complete closure of the school is essential in every case, as the exclusion of all children belonging to the infected area may, in many instances, meet the case. When several centres of infection exist in a scattered district, there is little doubt about the desirability of complete closure.

In densely-populated urban districts, on the other hand, where, apart from school attendance, the children freely associate together in the streets and houses, the advantage of closing the schools is not so obvious. At the same time, it is but reasonable to suppose that the risk run by meeting in the open air while at play is considerably added to by lengthened and close confinement in badly-ventilated class-rooms. On the whole, then, in arriving at a conclusion, while the consequences from an educational

point of view ought not to be lost sight of, should any doubt exist with regard to the advisability of complete closure, it is unquestionably the wiser course to err on the safe side.

There is still another course open, however—namely, the partial closure of a school. In the case of measles, for example, closure of the infants' department only is indicated as a rule. It is essentially an infantile ailment, and the systematic closure of the entire school during such epidemics would constitute a needless interference with educational work. It is satisfactory to find that Education Authorities are now discouraging, or even not providing for, the attendance of infants under five. On educational grounds this is a wise policy, and one which must also result in a lowering of the death rates from measles, whooping-cough, and scarlet fever, diseases in which both the susceptibility to attack and the fatality rapidly diminish after from three to four years of age.

It is important that school teachers should be informed of the existence of infectious cases when other children of the families attend the school, so that they may be in a position to prevent their attending. Teachers also may render valuable assistance to health officers during epidemics by notifying that certain children are absent from school owing to illness, as enquiry can then be made with regard to the cause. This assistance is usually willingly given, and is of value even now that the Notification Act is universally in force, as all cases are not considered serious enough to require medical attendance, and so the parents may plead ignorance of the nature of the ailment, and not report the cases.

Here, again, an exception should be made in the case of measles, and, possibly, whooping-cough. The probability is that the patient is an infant, and that two or three other children from the same house attend higher classes at the same school; to exclude the latter from attendance would frequently amount to practical closure of the whole school, and from what has already been said the argument against such a procedure will be readily appreciated.

The all-important question of **disinfection** has now to be considered, in relation to patients, rooms, and articles of clothing and bedding.

The terms **disinfectant** and **disinfection** ought only to be applied to substances or proceedings which are absolutely destructive of the virus of disease. They are seldom, however, used by the public in this strict sense. Many substances possessing merely

antiseptic properties (the power of arresting the development of germs), and even simple **deodorants,** are erroneously supposed to be disinfectants.

It has been proved that during certain stages in the development of disease organisms they are more tenacious of life than at others, and that what will suffice to kill the mature germ may be inoperative against the vitality of the *spores* or seed, which, surviving, continue to develop when favourable circumstances arise. A disinfectant, therefore, to be of any use, must not only **arrest the growth of,** but absolutely **destroy** the morbific agent; any action short of this, as already hinted, is worse than useless as regards checking the disease, for it gives a false security, and so encourages laxity in the exercise of other precautionary measures.

The following are the essential conditions in a true disinfectant :—

(1) *That it shall be capable of killing germs and their spores;* (2) *that it shall be applied to every part;* (3) *in sufficient strength;* (4) *for a sufficient time.*

These conditions have been established by experiment—the only safe method of arriving at a conclusion—and unless all are complied with, danger is not averted.

The experiments were conducted as follows:—A substance known to contain the virus of a certain disease, was subjected to the various methods of disinfection in use, and its virulence was afterwards tested by one of two methods—either by inoculating an animal susceptible to the disease in question, or by placing the material under conditions favourable to the development of the germs (cultivation), and observing the result. In the first case the animal will contract the particular disease unless the vitality of the germs has been absolutely destroyed, and in the second case failure is demonstrated by the fact that fresh germs will develop in the cultivating medium.

Of course these experiments were conducted with the utmost care, and the accuracy of the results was in all cases verified by "control experiments"—that is, by inoculating with or cultivating the same virus which had not been disinfected.

The particular germs selected for these experiments were those which are associated with anthrax disease (anthrax bacilli). These were chosen for two reasons—first, because they can easily be cultivated, and when inoculated into animals susceptible to the disease, they give rise to unmistakable symptoms; and secondly, because the spores of these germs

are not readily killed; therefore, what will destroy them will in all probability with greater certainty destroy those of other diseases.*

Process of Disinfection.

The process of disinfection is conducted in a variety of ways, according to the necessities of the particular case—that is, whether it be rooms, articles of clothing or bedding, discharges from patients, food and drink, etc., that are infected. The means at our disposal are—(1) **heat** (dry or moist); (2) **chemical substances** (in liquid or powder); (3) **fumigation** (by gases or vapours); and last, but by no means least, (4) **fresh air and general cleanliness.** Each will now be considered in the above order.

Heat is the best disinfectant we possess. By boiling an infected liquid or any article of clothing for ten minutes all ordinary disease-germs and their spores are destroyed. So, by exposing any infected article to steam at a temperature of 212° F., provided the second and fourth conditions (p. 210) are complied with, all danger is removed.

Dry heat is by no means so efficacious as moist. Experiments made by Drs. Parsons and Klein † show that it requires an exposure for a period of four hours to a dry heat, at a temperature a little over that of boiling water (212° to 216° F.), to destroy the spores of the anthrax germ; when the heat is raised to 245° F., however, one hour's exposure suffices. It must be remembered, however, that the latter temperature, as far as dry heat is concerned, very closely approaches the scorching point, most articles being injured by long exposure to a temperature above 255° F.

When the question of dry or moist heat is considered from the point of view laid down in the second *condition*, namely, *that it shall be applied to every part*, the advantage is again found to be in favour of the latter, because *the penetrating power of moist is much greater than that of dry heat.* Most articles that have to be disinfected in this manner—blankets, pillows, etc.—are bad conductors of heat, and as the infection is not confined to the exterior, but may penetrate into pillows and beds, and be enclosed in folds of blankets, it is essential that the temperature of

* For a simple account of the methods of cultivation, etc., of germs, see *The Story of the Bacteria and their Relations to Health and Disease*, by T. M. Prudden, M.D., published by G. P. Putnam & Sons.

† Supplement, 14th Annual Report Local Government Board.

the interior should be raised to the required point. The following figures show how difficult, indeed, how impossible it is, with dry heat, to arrive at this result. They are the outcome of 120 experiments conducted a good many years ago by Sir Arthur Whitelegge, with one of the best hot-air disinfecting apparatus in the market (Ransom's), and the figures given represent the mean of those obtained in the series.

During the whole period of exposure, the air introduced into the apparatus was heated to a temperature of 255° F., while the registered temperature of the escaping air at the end of the experiments ranged from 245° to 250° F.

REGISTERING MAXIMUM THERMOMETERS PLACED BENEATH LAYERS OF BLANKETS.

Duration of exposure.	2 Layers.	4 Layers.	6 Layers.	12 Layers.	18 Layers.
4 hours, . .	220° F.	206° F.	190° F.	162° F.	139° F.
6 " . .	226° F.	214° F.	208° F.	174° F.	153° F.
8 " . .	230° F.	221° F.	215° F.	196° F.	182° F.

The contrast between these results and those obtained by another series of experiments with steam disinfecting apparatus, is very remarkable, and demonstrates conclusively the advantage of moist as compared with dry air. "An electric thermometer set so as to ring at 212° F., was placed between sixteen or more layers of blankets, and served to indicate the exact interval between the first exposure to steam and the attainment of the required temperature—namely, 212° F. . . . the maximum interval noticed was 17 minutes." * An account of further and more extended experiments regarding the value of steam as a disinfectant is given later, p. 217.

Not only, therefore, is steam greatly superior to hot air, but the economy in time required for the completion of the process is immense. Remembering also what has been said with regard to the inferiority of dry as compared with moist heat at the same temperature, even when in perfect contact with the infected article, and, considering that the one fails to do in eight hours what the other can accomplish in seventeen minutes, there is little question as to which should have the preference.

* *Hygiene and Public Health*, Whitelegge.

In the face of what has been said it may be asked, "Is it worth while continuing to make use of a hot-air apparatus?" The answer is—"Most certainly, if a steam apparatus cannot be obtained, only, take warning from what has been said, and continue the process for at least four hours after the thermometer has registered a temperature of 255° F. in the interior of the chamber." It must be remembered that the experiments upon which the requisite temperature has been fixed were conducted with a disease virus which, compared with others, is not easily destroyed, and it is possible that a lower standard may meet the case as regards some infectious diseases, although the higher standard should be aimed at. The use of steam is inadmissible in the case of leather articles and bound books, as it destroys them, but, with those exceptions, it is less injurious to clothing, etc., than hot air.

The superior penetrating power of steam is attributed by Dr. Parsons to a variety of causes, and the following lucid description of the two principal ones is taken from Prof. A. Wynter Blyth's *Manual of Public Health*:—

1. "Probably the most important is the large amount of latent heat in steam. To convert 1 lb. of water at 212° F. into steam at 212° F. requires nearly 1,000 times as much heat as it does to raise 1 lb. of water from 211° to 212° F. Conversely a corresponding amount of heat is liberated when 1 lb. of steam at 212° F. is condensed into water at 212° F. When an object is heated by being placed in hot dry air, not only is no latent heat yielded up to it by the air, but on the other hand, before the object can attain the temperature of 212° any water which it may contain (and all textile fabrics, even though dried at ordinary temperatures, retain a quantity of hygroscopic moisture) must be evaporated; in this evaporation heat passes into the latent form, and the attainment of the required temperature is thus delayed.

2. "When steam penetrates into the interstices of a cold body it undergoes condensation in imparting its latent heat as aforesaid to the body. When condensed into water it occupies only a very small fraction of its former volume. To fill the vacuum thus formed more steam presses forward, in its turn yielding up its heat and becoming condensed, and so on until the whole mass has been penetrated. On the other hand, hot air in yielding up its heat undergoes contraction in volume, it is true, but only to a very small extent as compared with that undergone by steam in condensing into water. Thus air at

250° F. in cooling to 50° F. would contract to $\frac{5}{7}$ of its previous volume."

It has now been proved that what is termed **saturated** steam is far more efficacious than **superheated** steam, and it is said that, in the absence of air, penetration is more perfect and condensation takes place in more intimate contact with the fine particles of infected matter. For this reason, certain apparatus are provided with special air exhausts.

Washington Lyon's steam apparatus was the first of the modern efficient apparatus used in this country. It consists of an oval chamber with double walls, and a door at each end fastened by screw-clamps, one for the introduction of infected articles, and the other for their removal when the process of disinfection is complete. Steam is discharged into the apparatus by two pipes, the one communicating with the cavity formed by the double walls, and the other with the interior of the chamber, the amount of pressure in each case being indicated by pressure gauges. The object of surrounding the chamber with this "jacket" of steam is, in the first place, to prevent loss of heat, and secondly, to check condensation. The pressure now recommended to be used by the makers is 30 lbs. per square inch in the jacket, and 20 lbs. in the interior. The articles to be disinfected are conveyed to a room at the inlet end of the apparatus, the walls and floor of which ought to be non-porous, to facilitate cleansing, and which must be completely separate from the receiving room at the outlet end. Having obtained a pressure of 30 lbs. in the jacket, the articles are placed in the wire-cage or suspended on the rack provided for the purpose, and are then pushed into the chamber along rails. By means of an ejector a partial vacuum is then created in the chamber with the view of facilitating the penetration of the steam into the clothing, and the steam is afterwards introduced and maintained at a pressure of 20 lbs. for about half-an-hour. The steam is then turned off from the interior and the door at the reverse end of the apparatus is opened. To assist the drying process, the articles may be left in the chamber for a short time longer exposed to the heat derived from the steam in the jacket, which has not yet been turned off.

Another form of steam disinfecting apparatus is manufactured by Goddard, Massey & Warner, which differs in certain details from Lyon's; and still another, van Overbeck de Meyer's, which is designed for steam at atmospheric pressure. Both these have been favourably reported upon.

In the **"Equifex" apparatus,** manufactured by Defries & Sons, saturated steam is employed at a pressure of 10 lbs. to the square inch, therefore, at a temperature of 239° F., and an arrangement is provided by which the air is automatically removed from the interior of the apparatus before the steam enters. This is a very perfect disinfector.*

Reck's steam disinfector, which is the invention of Captain Reck, an engineer in Copenhagen, is an inexpensive, simple, and efficient apparatus. Previous to its introduction into this country it was not possible to obtain an efficient apparatus at a moderate cost, but it now has rivals, competition having brought down the price of the English makers, while, at the same time, efficiency has not been lost sight of.

The apparatus are made in various sizes, and oval or rectangular in shape. Current steam, at a pressure varying from $1\frac{1}{2}$ lbs. (216° F.) to 7 lbs. (230° F.), is the disinfecting agent, the pressure being controlled by an automatic regulator. Originally the apparatus was made with a detached drying chamber heated by the exhaust steam, and an arrangement existed for rapidly condensing the steam in the apparatus at the end of the process by means of a sudden rush of cold water on to a deflecting plate fixed within and at the top of the apparatus. While this form of apparatus is still made, another form (Figs. 104 and 105) has more recently been introduced, in which the cold water shower is omitted, and the drying of the articles is effected within the apparatus itself by means of heat imparted by a hot-water jacket surrounding the greater part of the chamber, after the steam has been shut off; this, it is said, suffices to dry the articles within a reasonable time. The design of this apparatus, and the objects served by its various parts will be understood from the two drawings, and especially from the lettered section with descriptive notes. This form of the apparatus has been thoroughly tested by Dr. Thoinot, of Paris, who came to the conclusion that it "surpassed other disinfectors then used in the French hospitals."

Reck's disinfector, with separate drying arrangement, was shown at the exhibition connected with the Sanitary Institute Congress held in Liverpool in the autumn of 1894, and, on the

* For a description of what is meant by the term *saturated* steam, see a paper on "The Theory and Practice of Disinfection by Heat," read by Wolf Defries, B.A., M.I.Mech.E., at the Sanitary Institute Congress held in Liverpool in 1894, an abstract of which will be found in the Quarterly Journal of the Institute published in January, 1895.

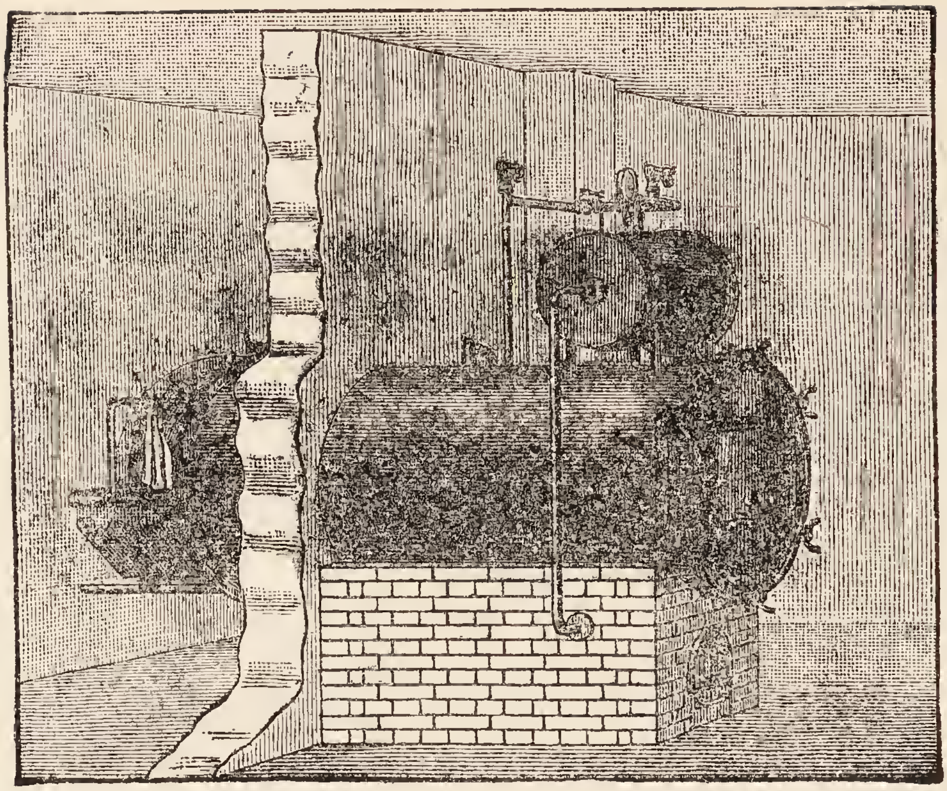
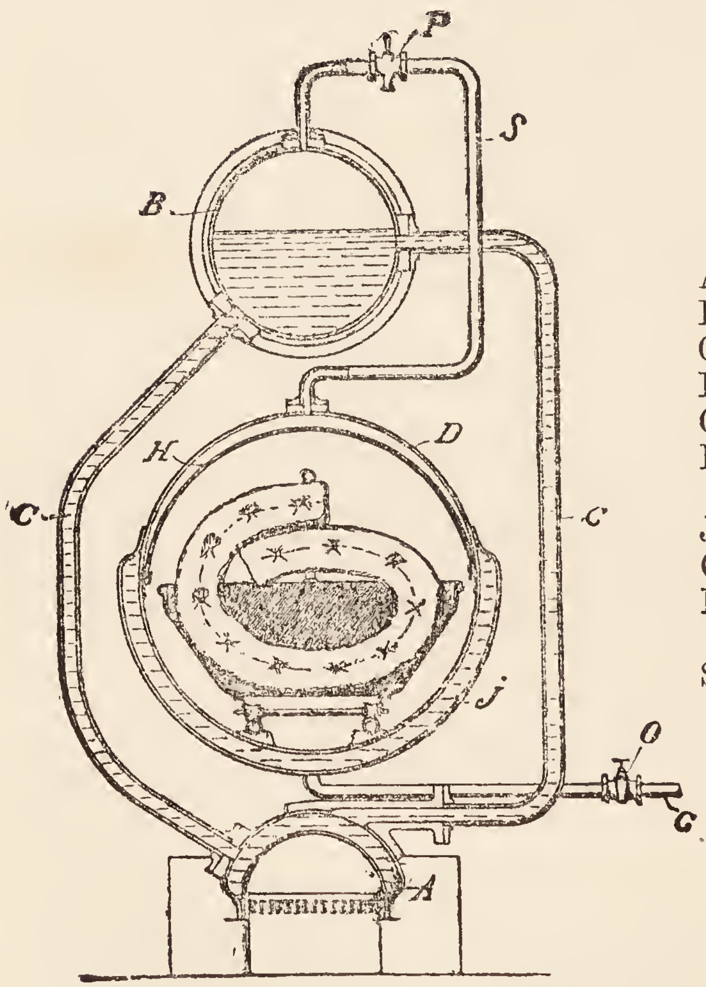


Fig. 104.



A, Saddle boiler.
B, Steam drum.
C, Circulating pipes.
D, Disinfecting chamber.
G, Open exit pipe.
H, Screen for breaking the current of the steam.
J, Water jacket.
O, Perforated valve.
P, Automatic pressure regulator.
S, Steam pipe from drum to disinfecting chamber.

Fig. 105.

author's suggestion, the inventor kindly had the apparatus (the cylindrical form measuring 7 feet by 3 feet) fixed in Stafford after the closure of the exhibition to allow of its power being tested. In these trials the author had the advantage of the valuable help of Drs. Whitelegge * and Barwise, the County Medical Officers of West Riding of Yorkshire and Derbyshire, and Dr. Blumer, the Medical Officer of Health of Stafford.

The special features of this, the original Reck apparatus, with separate drying arrangement, are—(*a*) the use of low-pressure steam, delivered to the apparatus by an automatic regulator at a rate which cannot be exceeded, (*b*) the absence of any steam jacket, and (*c*) an arrangement by which a cold water shower can be turned into the chamber with the object of rapidly removing all steam from the interior after the process of disinfection is completed. As regards the cold shower it is introduced at the top of the apparatus and falls on to an umbrella spread in the upper part of the hot chamber which distributes the stream over a large surface and conducts the water to the lower part of the apparatus, where it escapes in such a manner that it does not come in contact with the articles which are being disinfected. The result of the sudden introduction of the cold shower is a rapid cooling and the condensation of all live steam in the chamber, this steam being automatically replaced by air entering through a valve in the front of the apparatus as fast as the steam is condensed by the cold water.

In the experimental trials the pressure employed did not exceed $1\frac{1}{2}$ lbs., and they were conducted with the view of ascertaining :—(1) the penetrating power of the low-pressure steam, and the temperatures obtained in various thicknesses of clothing ; (2) the degree of moisture remaining in the articles after the process ; and (3) the destructive power of the apparatus as regards organisms.

By means of an electric thermometer, set to ring at 212° F., and recording maximum thermometers placed between various folds of blankets, etc., the rapidity of penetration, and the temperatures under different conditions as regards resistance were ascertained. The amount of moisture remaining in the articles was estimated by weighing them before and after the process. As regards the efficiency of the apparatus, its power of destroying various bacteria, suspended in the chamber and placed in folded blankets and between mattresses, was ascertained by cultivation experiments.

* Now Sir Arthur Whitelegge, H.M. Chief Inspector of Factories.

The following table shows the temperature attained under various conditions :—

In 15 Minutes—Folds of Blankets.			In 35 Minutes.		
4 Folds.	8 Folds.	16 Folds.	In Chamber.	In 16 Folds, Blankets.	Between Mattresses.
219°	218°	212°	215·6°	220°	211°

As regards the rapidity of penetration, it may be considered highly satisfactory, for it probably does not often happen in actual experience that greater resistance than is represented by 16 folds of woollen material will have to be overcome, and that the results recorded in the table can be attained by the Reck apparatus was demonstrated by a series of tests. To place the thermometer between two thick flock mattresses is a very severe test, and it speaks well for the apparatus that in 35 minutes after the introduction of the steam a temperature within 1° of boiling point was recorded. It is interesting to note that the temperature in the cavity of the chamber was over 4° lower than the recorded temperature within 16 folds of blankets—a circumstance which may possibly be accounted for by the liberation of latent heat owing to condensation in the interstices of the material.

As regards the dryness of the blankets at the end of the process, the following are the results with and without using the cold water shower :—

	Without Cold Shower.								With Cold Shower.					
	Two Blankets		Four Blankets.						Two Blankets		Four Blankets.			
	1		2		3		4*		5		6		7*	
	lbs.	ozs.	lbs.	ozs.	lbs.	ozs.	lbs.	ozs.	lbs.	ozs	lbs.	ozs.	lbs.	ozs.
Weight before introduction,	6	$5\frac{3}{4}$	12	2	12	2	12	2	6	$5\frac{3}{4}$	12	2	12	2
Weight on removal, .	6	9	12	$9\frac{1}{4}$	12	$7\frac{1}{4}$	12	$9\frac{3}{4}$	6	$9\frac{1}{4}$	12	$8\frac{1}{4}$	12	$9\frac{3}{4}$
Weight after shaking in open air,	6	$6\frac{3}{4}$	12	4	12	3	12	7	6	$6\frac{3}{4}$	12	$4\frac{1}{4}$	12	$7\frac{1}{4}$

* In the fourth and seventh experiments the blankets were hung loosely in the apparatus; in the others they were folded compactly.

Taking the means of these figures, and expressing the degrees of dampness by the percentage increase of weight in each case the following results are arrived at :—

			Percentage Increase in Weight.
Blankets compactly folded.	Without shower,	On removal from apparatus,	2·6
		After shaking in open air,	0·8
	With shower,	On removal from apparatus,	3·3
		After shaking in open air,	1·1
Blankets loosely suspended.	Without shower,	On removal from apparatus,	4·0
		After shaking in open air,	2·6
	With shower,	On removal from apparatus,	4·0
		After shaking in open air,	2·7

It would seem then that the cold shower does not assist in the drying process, nor is it claimed for it that it does, but it has a very marked effect in condensing the steam in the apparatus; without it volumes of steam escaped on opening the door, whereas, with it little or no steam was perceptible. That the shaking process is less effectual in removing moisture in the case of blankets loosely suspended in the apparatus is no doubt explained by the fact that the heat is largely retained in blankets which are folded up, and when they are suddenly shaken in the air evaporation would naturally be more active than it would in the case of blankets which, owing to the large surface exposed, had cooled considerably before the shaking while being removed from the apparatus.

As regards the bacteriological tests, which Dr. Barwise kindly conducted, anthrax bacilli and spores, garden soil, and human excreta were used, and, with the exception of a few soil bacteria, which are known to be highly tenacious of life and which survived the process, this part of the experiment was entirely successful, as was proved by control experiments in every case. The bacteria, as already mentioned, were placed free in the chamber, as well as within 16 folds of blankets, and between two flock mattresses, and subjected to the prescribed routine of treatment, and in no instance, with the above exception, did any growth take place on gelatine in the case of the disinfected specimens, while in every instance duplicated specimens which had not been treated in the apparatus freely germinated on gelatine plates.

To sum up then, the experiments seem to warrant the conclusion that in Reck's disinfector we have a very efficient apparatus capable of destroying the ordinary pathogenic microbes.

The pre-war cost of an apparatus similar to the one experimented with, including the drying chamber complete and all necessary appliances, amounts to £77, very much less than other equally efficient apparatus hitherto used in this country. Probably a smaller apparatus would answer the requirements of public institutions and smaller districts, in which case, of course, the cost would be less.

An adaptation of Reck's apparatus is made in portable form and of a size corresponding with the one experimented with at Stafford—perhaps the most useful size for general use. The weight of this portable apparatus is just over 27 cwts., and its pre-war cost £225. When the provision of disinfecting apparatus becomes more general, and rural as well as urban Sanitary Authorities come to look upon such appliances as being essential to the efficient control of infectious disease, the probability is that the portable form will be more generally used.

Thresh's disinfector, designed by Dr. Thresh, late County Medical Officer, Essex, is a current steam apparatus, by means of which a temperature exceeding 212° F. is obtained without employing pressure. This is accomplished by using for the generation of the steam a saline solution which boils at a higher temperature than water. The apparatus is simple, ingenious, and efficient, and it costs very much less than others in which high-pressure steam is used.

The following drawing (Fig. 106), showing a section of the apparatus, will enable the reader to understand its construction. It will be noticed that the chamber in this case has only one door, but the apparatus is also made with two doors, one communicating with a room where the infected articles are introduced, and the other with an entirely distinct room, where the articles are removed on the completion of the process of disinfection. The principle of construction, however, in both cases is the same.

The disinfecting chamber, A, is surrounded by a jacket, B, containing the saline solution, which is maintained at a certain level, and renewed as evaporation takes place by means of a water pipe, L, connected with a ball-tap cistern, I, fixed outside the apparatus. The furnace, K, for heating the saline solution is constructed underneath the chamber, and the steam which is thus generated in the upper part of the jacket can be directed by means of a valve, G, either into the chimney of the furnace, or downwards to a coil of pipes, E, laid in the solution at the bottom of the jacket, through which it circulates before entering the

chamber at the point, C. Passing from the upper part of the chamber to the furnace flue is a pipe, D, which allows the steam to escape from the interior of the chamber.

Communicating with the coil of pipes, E, in the bottom of the jacket is a pipe which is protected by a valve, F, which, when open, allows air to pass along these pipes, and into the apparatus at the point, C, already mentioned. The process is conducted as follows:—Having heated the solution in the jacket to boiling point, during which process the valve, G, is adjusted so that the steam is discharged into the chimney, the articles of clothing are

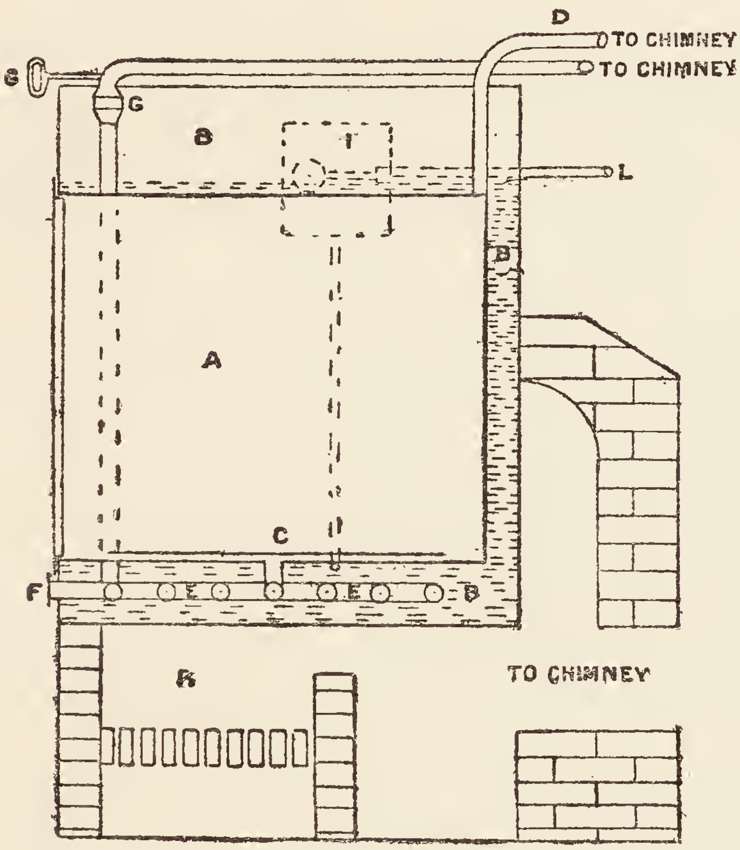


Fig. 106.—Thresh's disinfecting apparatus.

placed in the disinfector, and, having closed the doors, the steam is directed, by means of the valve, into the chamber, through which it passes in a continuous stream, having traversed the pipes, E, where any heat which may have been lost by surface-cooling in the cavity of the jacket is supplemented This stage of the process is allowed to continue for thirty-five minutes, and, the disinfection being now accomplished, the valve, G, is closed to the chamber and opened to the chimney, and at the same time the valve, F, is opened, thus allowing a current of air, which has been warmed by passing along the pipes, E, in the boiling

solution, to enter the chamber at the point, C, for the purpose of airing the articles before removal.

The salt which is dissolved in the water is chloride of calcium, and the boiling point is regulated by the strength of the solution. The solution recommended by Dr. Thresh boils at 220° F., and gives off steam at about 215° F. Of course, the water which is lost by evaporation is constantly replaced by the cistern, but the chloride of calcium never requires renewal. A portable form of this apparatus is also made.

Dr. Thresh has also designed a cheap portable "emergency" apparatus in which current steam charged with the vapour of formic aldehyde is employed. The apparatus is simple and efficient, and only costs about £25.*

Among the more efficient **chemical disinfectants** now practically available in a fluid form are—solutions of **corrosive sublimate** (bichloride of mercury), **carbolic acid** (phenol), **"izal," "lysol," "formalin," "cyllin,"** and **"chinosol,"** the requisite strength of the first named being 1 part in 1,000; of the second, 5 parts in 100; and of the five last named, 1 part in 100.

Carbolic acid has long been in popular favour as a disinfectant, but, as a rule, it has been used in such a diluted form as to reduce it to an ordinary deodorant, or at best an antiseptic. Wynter Blyth † summarises the estimate he formed of it, as the result of his own experiments and those of others, as follows:—" . . A 1 per cent. solution is strong enough to destroy the more feeble infections, but to be certain that the more resistant forms of germ life are annihilated it will be necessary to use at least 5 per cent. solution in water, and the action must be prolonged; if specific excreta are treated it is doubtful whether 5 per cent. solutions are of sufficient strength, because associated with the hurtful material there is a quantity of organic matter which must on the one hand remove some of the phenol from the sphere of action, and on the other impede the contact of the phenol with the substance which we wish to disinfect."

Dr. Klein has shown that anthrax spores will resist a 5 or 6 per cent. carbolic acid solution for forty-eight hours, but it must be remembered that these organisms are very highly resistant.

In talking of the efficiency of a disinfectant of a certain strength, it is necessary to bear in mind that it must come in contact with the germs to be destroyed without undergoing

* For description and report of tests, see *British Medical Journal*, June 28, 1902, p. 1606.

† *Manual of Public Health.*

further dilution, and remain in contact with them a considerable time, so that, if the material to be disinfected is bulky, the strength of the disinfecting solution must be increased accordingly. It is obvious from this that the thorough disinfection of sewage is hardly practicable.

Corrosive sublimate is a far more potent disinfectant than carbolic acid, as solutions only $\frac{1}{50}$ the strength (1 : 1,000) are requisite. Unfortunately, its extremely poisonous character interferes with its usefulness, but if it be artificially coloured (it is naturally colourless), and kept only in specially-shaped bottles with a prominent poison-lable attached, the risk ought to be reduced to a minimum.

"**Formalin**" is the name given to a 40 per cent. solution of a gaseous alcoholic compound, known as *formic aldehyde.* A solution of from 1 to 2 per cent. of this substance acts as a powerful disinfectant, and owing to its active properties in this direction, and to the fact that it is non-poisonous, it has recently come into great favour. Compared with carbolic acid, not only is it a more potent disinfectant, but in solution of equal germicidal strength it costs considerably less. In its gaseous form it is now used for room disinfection, as will presently be described.

"**Izal,**" "**cyllin,**" "**lysol,**" "**cresol,**" "**kerol,**" "**Jeye's fluid,**" and "**chinosol**" are patented substances, which are now taking the place of carbolic acid and other older disinfectants. They are harmless, readily soluble, and, as liquid disinfectants, they now take a high place. As regards germicidal properties, they appear to be greatly superior to carbolic acid, and it is said that, when this is taken into account, they also compare favourably in price.

Chlorine in solution has lately been more highly recommended than formerly. Prof. Delépine strongly advocates its use as a cheap and reliable disinfectant, and Sir German Woodhead, Dr. Klein, and others also highly recommend it.* A solution of sodium hypochlorite, containing 10 per cent. available chlorine, is sold under the name of "**chloros,**" and has strong germicidal properties when diluted ten times. For room disinfection, Prof. Delépine recommends the washing of the walls with a 1 per cent. solution of chlorine, and in this he is supported by Sir German Woodhead. For some years now this has been the method of room disinfection adopted at Stockport, and the late † Medical Officer of Health, Dr. Porter, says that it has answered admirably.

* *Journal of the Sanitary Institute,* vol. xviii. (1898).
† Now Medical Officer of Health of Johannesburg.

Potassic permanganate in 5 per cent. solution acts as a disinfectant when tested experimentally, but in practice it is necessary to use it in such large quantity as to forbid its use for any other than deodorising or antiseptic purposes. This arises from the fact that the permanganate is used up in oxidising the organic matter present in the infected fluid.

Concerning the other so-called disinfectants, namely :—*Chloride of zinc, sulphate of zinc, sulphate of copper, sulphate of iron, boracic acid, etc.*, experiment has proved that in practice they come short of what is required in a true disinfectant.

Fumigation, by any of the reagents commonly used, has been shown by experiment to be far less effective than has hitherto been supposed. In practice, possibly all we can hope to accomplish is destruction of the less resisting organisms and nothing more than surface disinfection can be looked for, as penetration of fabrics does not take place.

Koch and others have demonstrated that *sulphurous acid*, when present in the proportion of 1 per cent. of the space to be fumigated, will destroy the germ of anthrax in half an hour, but that six times that amount is inoperative against the spores of the same organism even after several days' exposure.

It has also been shown that the slightest covering will protect the germs from the effect of the reagent; for example, those that were enclosed in the pocket of a coat escaped destruction—from this it is clear that any infection other than that which is adherent to surfaces, is likely to retain its virulence after the process has been completed.

Sulphurous acid is generated by burning sulphur, broken into small pieces, in an iron vessel, and the quantity required to yield 1 per cent. of sulphurous acid is 1 lb. per 1,000 cubic feet of room space. As already indicated, however, this form of disinfection is far from efficient, and recent tests show that 3 lbs. per 1,000 cubic feet should be used to obtain the best results.

The process is conducted in the following manner :—Having carefully sealed all openings in the room, such as the fire-place, the spaces round the window-sashes, and any ventilating openings that may exist, by pasting brown paper over them, the articles of furniture, and all articles that cannot be boiled or otherwise disinfected, should be arranged so as to be as freely exposed as possible to the fumes. The necessary quantity of sulphur is then placed in one or more vessels (a sauce-pan answers very well) according to the size of the room—in a large room it is best to use two or more, placed well apart—and, as a pre-

caution against fire, it is advisable to place each on two bricks, standing in a tray containing water, or supported on a pair of tongs over a bucket of water. Having added a little methylated spirit to facilitate lighting, the sulphur is then set fire to, and the operator must at once leave the room, close the door, and paste paper all round it. Of course if there is more than one door in the room, the others should previously be similarly sealed. The room must be left undisturbed for six hours, when the windows must be thrown freely open, and allowed to remain so for at least twenty-four hours. The furniture and other articles ought then to be carried into the open air, where they should undergo a thorough brushing and beating, and be left exposed to the air as long as possible.

Chlorine gas is another reagent which is preferred by some. The proceeding in this case, as regards the room, is the same as when sulphur fumigation is practised. The most convenient method of generating the gas is by adding strong hydrochloric acid to chloride of lime, in the proportion of $1\frac{1}{2}$ to 2 pints of the former to each pound of the latter, and this is the quantity recommended per 1,000 cubic feet of space. In this case ordinary basins must be used, not metallic vessels, and several of them should be placed at various elevations about the room. As the gas, which is very poisonous, is given off immediately, it is necessary that the acid should be conveniently placed near each basin, so as not to cause any delay in the operation, and the operator must notice that the door is open so as to allow of his immediate exit. The room ought to remain closed for twelve hours.

The after treatment of the room, no matter what fumigant is used, is very important, and here it is that the mechanical effect of soap and water is of service as a disinfectant. If the room has previously been papered it is a wise precaution to strip off the old paper and repaper the walls, but in practice this rather drastic remedy cannot usually be employed. If, on the other hand, the walls have been coloured, they should be scraped and lime-washed, or at least the latter. Painted walls must be thoroughly washed with soap and water, as must also the floor and all articles of furniture that allow of it.

Formic aldehyde vapour is now highly recommended by well-known authorities as a room disinfectant, and as it has now almost entirely superseded sulphur fumigation it is necessary to devote some space to a description of the process. As has already been stated it is a thoroughly reliable disinfectant in

solution ("formalin"), and although in its vaporous form it is admittedly less efficacious, there can be no question that in practice it is superior to sulphur fumigation.

For some time, apart from the more elaborate apparatus to be presently referred to, the only conveniently available method of evolving the vapour was by means of the Alformant "A" lamp, by evaporating tabloids of "paraform." Now, however, an undoubtedly more efficient, and by no means elaborate, apparatus has been introduced, called the Lingner disinfecting apparatus. The drawing, with a section of the working parts (Fig. 107), represents this apparatus, which consists of a circular boiler, A, for generating steam, surrounding a reservoir, B, containing a 40 per cent. formic aldehyde solution, or a special preparation called "glycoformal" (a mixture of

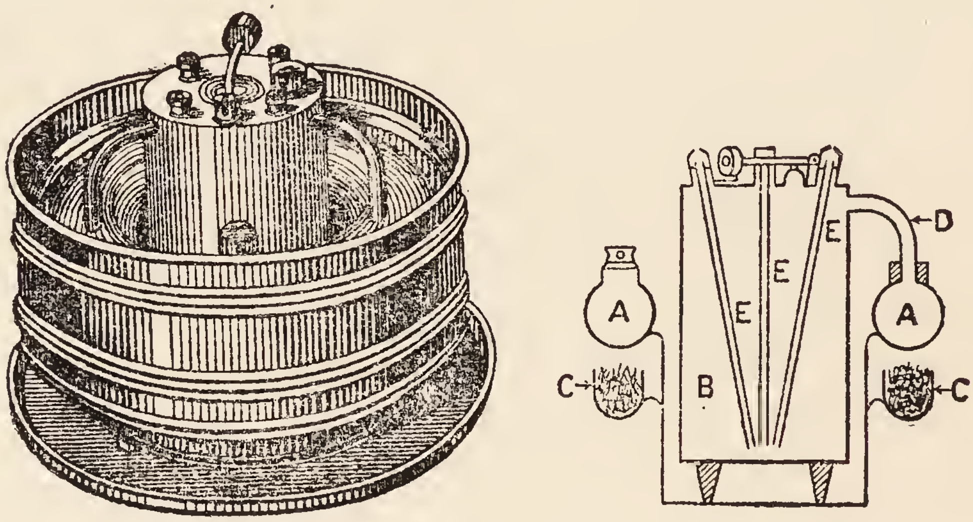


Fig. 107.

formic aldehyde, glycerine, and water). The working of the apparatus will be understood from the following description with the aid of the sectional drawing. The heating medium is methylated spirit with which asbestos, in the circular trough, C, under the boiler, is saturated; and the steam passes from the boiler into the reservoir through connecting pipes, D, and forces the formic aldehyde, in a vaporised state, through four nozzles connected with tubes, E, into the room. Experiments with the apparatus have been conducted by Dr. Klein, who found that by a three hours' exposure to formic aldehyde vapour discharged from it in a sealed up room virulent spores of *Bacillus anthracis* and virulent tubercule bacilli were destroyed, and he states that the results compared most favourably with those previously obtained by

him in conjunction with Drs. Houston and Gordon with the Alformant lamp, which are referred to later.*

In place of using this substance in a gaseous form some advocate its use in solution in the form of a spray. Dr. Leslie Mackenzie strongly advocates this method of room disinfection.† For highly efficient disinfection Dr. Kenwood recommends the use of a spray containing 0·5 per cent. formic aldehyde followed by the fumigation process.

As in the case of all fumigation processes, it is necessary to seal up the room openings, and the room should be kept closed for six hours.

In this country the value of formic aldehyde as a disinfectant has been tested chiefly by Mr. Wynter Blyth and Drs. Kenwood and Rideal, and the conclusions they have arrived at may be summed up as follows :—

Mr. Blyth states that excellent results were obtained from the evolution of a large quantity of the gas in a small room by means of an autoclave, but having failed to obtain such good results from the Alformant lamp, he recommends its reconstruction so as to allow of a much larger quantity of paraform being used.‡

Dr. Kenwood concludes that although the best results are only obtainable by means of the more elaborate apparatus, considering the probable comparatively feeble resisting power of the organisms we wish to destroy, sufficiently good results can be obtained by the Alformant lamp, provided the greatest care is taken to seal the room. The number of tablets used by him in his experiments was twenty-one for a room of 2,004 cubic feet capacity, the organism used as a test being the diphtheria bacillus.§

Dr. Rideal concludes that sufficiently good results can be obtained by the Alformant lamp by using ten tablets per 1,000 cubic feet, and that, in addition, by spraying the walls with a 0·5 per cent. formic aldehyde solution, the best practical disinfection would be insured.||

Dr. Kanthack, Professor of Pathology at Cambridge, has experimented with the Alformant "A" lamp, and, by way of comparison, with a more complicated apparatus (*Formogene*

* The Agents for the sale of this Lingner apparatus in this country are The Odol Chemical Works, 26 Southwark Bridge Road, London, S.E.

† *The Lancet*, 13th August, 1898, p. 445.

‡ *Public Health*, vol. ix., p. 299 (June, 1897).

§ *Journal of the Sanitary Institute*, vol. xviii. (1898).

|| *Disinfection and Disinfectants*, Second Edition (1898), p. 332

Richard lamp), by means of which the vapours are generated by the incomplete combustion of strong wood spirit. His experiments undoubtedly show that the Formogene Richard lamp is far more efficacious than the Alformant lamp, at the same time it is doubtful whether its somewhat complicated nature and the conditions of efficient working would not militate against its success in practice.

The following is a summary of Dr. Kanthack's principal conclusions :—

1. That the Formogene Richard lamp is much more certain than the Alformant lamp.
2. That even in comparatively small rooms it is desirable to use two lamps.
3. That formic aldehyde does not penetrate deeply, so that it cannot be used for the sterilisation of blankets, linen, etc., heaped one upon the other ; it is merely a superficial disinfectant.
4. That it does not damage metals, dyes, or most colours, although it may slightly alter some aniline dyes.
5. That, therefore, if sufficiently produced, formic aldehyde is useful for the superficial disinfection of such substances as are injured by steam or liquid disinfectants, or by irritant gaseous bodies such as chlorine.*

From the conflict of opinion above recorded, it is difficult to arrive at a very definite notion regarding the true practical value of this means of disinfection. The following, however, are probably the safe conclusions to arrive at :—

1. That surface disinfection only can be expected, and that with that limitation the process is reliable in practice.
2. That preliminary spraying with from $\frac{1}{2}$ to 1 per cent. formic aldehyde solution will greatly add to the efficiency of the process.

On behalf of the London County Council Drs. Klein, Houston, and Gordon conducted a series of experiments to test the antiseptic powers of certain disinfectants, both gaseous and liquid. Among the former the best results were obtained from formalin vapour, although it failed in the case of some of the more resistant organisms or their spores. Less satisfactory results were obtained from sulphur dioxide, even when $3\frac{1}{2}$ lbs. of sulphur were burnt in a room with a capacity of 1,075 cubic feet. As regards the fluid disinfectants, corrosive sublimate, 1 in 1,000 solution, gave good results, the next being carbolic acid in 5 per cent. solution, while Condy's fluid was of very little

* *The Lancet*, 22nd Oct., 1898, p. 1049.

use, and bleaching powder (1 per cent. solution) was only efficacious with the feebly resistant organisms. The report on these experiments emphasises the difficulty of disinfecting cloth and unvarnished or, in other words, porous wood.

General Preventive Measures against Epidemic Disease.

The following verbatim copy of the last memorandum issued by the Local Government Board as to the precautions required against epidemic disease should be *most carefully studied* by every one whose duty or interest it is to promote public health :—

"Since epidemic diseases differ from one another in their nature and mode of propagation, the measures appropriate for their prevention will similarly vary; thus the measures of prevention necessary to arrest the spread of diseases which are spread like small-pox or measles from person to person, differ more or less from those necessary in the case of diseases in which, like cholera and enteric fever, the infective matter is given off from the sick especially in the intestinal discharges, and which are, therefore, liable to be spread by means of excremental nuisances and polluted drinking water. A third method in which epidemic diseases may be spread is by the consumption of infected articles of food, more especially of milk or shell-fish. Moreover, the same disease may on different occasions be propagated through different channels; thus, scarlet fever or diphtheria may at one time be spread by means of personal intercourse between infected and healthy persons at school or elsewhere; at another time by the distribution of infected milk. It is evident, therefore, that measures of precaution, if they are to be rational and effective, must be based on a knowledge of the natural history of the disease which threatens, and of the channels of communication open for its spread in the particular case; and this presupposes skilled medical advice, such as it is the duty of the Medical Officer of Health to render. This memorandum, therefore, offers only general advice, the application of which in particular instances must depend on the circumstances of the case.

"In order that effectual measures of prevention against epidemics may be taken, the first and most essential requisite is to obtain immediate information of the first cases of the disease. It rarely happens that a serious outbreak of infectious disease results from a case which is promptly recognised and

dealt with; usually such an outbreak has its origin in a case which has passed unrecognised, sometimes through wilful concealment, but more often through want of familiarity with the disease, or through the case being of a mild or non-typical character. When an epidemic threatens, therefore, careful watch should be kept for these mild and unrecognised cases; thus, when small-pox threatens, every vesicular or pustular rash should be looked on as suspicious; when scarlet fever or diphtheria is in question, every sore throat should be similarly regarded. Moreover, it is now known that infective micro-organisms may exist in the bodies of, and be conveyed by, persons who themselves show at the time no symptoms of disease. Thus in a certain small percentage of cases the bacilli of enteric fever persist, or appear intermittently, in the intestinal discharges or urine of persons who have suffered from an attack of that disease, even for years after recovery. The bacillus of diphtheria is occasionally found in the throats of persons who have associated with diphtheria patients, but who themselves show no sign of illness. The infectivity of diphtheria and scarlet fever may continue for a considerable period after convalescence, or may apparently revive on the occurrence of a local ailment, evidenced, for instance, by sore throat or discharge from the nostrils.

"1. Wherever there is prevalence or threatening of cholera, diphtheria, fever, or any other epidemic disease, it is of more than common importance that the statutory powers conferred upon Local Authorities for the protection of the public health should be well exercised by those Authorities, acting with the advice of their Medical Officers of Health, and that careful watch should be kept for what may prove to be the initial cases of such diseases.

"2. Proper precautions are equally requisite for all classes of society. But it is especially with regard to the poorer population, resident in the courts and alleys of towns, and in the labourers' cottages of country districts, that Local Authorities are called upon to exercise vigilance, and to proffer information and advice. Common lodging-houses and vagrant wards always require particular attention, in view of the liability of the class of people who frequent these places to contract and carry about infectious disease.

"3. All reasonable care should be taken not to allow infective disease to spread by unnecessary association of sick with healthy persons. This care is requisite, not only with regard to the sick house, but likewise with regard to schools and other establish-

ments wherein the members of many different households are accustomed to meet.

"4. If infectious disease begins in houses where the sick person cannot be properly accommodated and tended, he should be removed, if practicable, to an isolation hospital. Every Local Authority should have in readiness a hospital for the reception of such cases.

"Where the patient cannot be removed and where dangerous conditions of residence cannot be promptly remedied, it may be advisable that the inmates not in attendance on him should, while unattacked by disease, remove to some safer lodging.

"Persons who have been in association with the sick should be kept under observation for a time corresponding to the longest known period of incubation of the disease in question, dating from the latest exposure to infection.

"5. Overcrowding should be prevented. Especially where disease has begun, the sick-room should, as far as possible, be free from persons who are not of use to the patient.

"Ample ventilation should be enforced. It should be seen that windows are made to open, and that they are sufficiently opened. Especially where any kind of infective fever has begun, it is essential, both for patients and for persons who are about them, that the sick-room and the sick-house be constantly traversed by streams of fresh air.

"6. The cleanliest domestic habits should be enjoined. Refuse matters should be speedily removed or destroyed; and things which have to be disinfected or cleansed should always be disinfected or cleansed without delay. The influence of exposure to sunlight and fresh air in the destruction of infection should be borne in mind.

"7. Special precautions of cleanliness and disinfection are necessary with regard to infective matters discharged from the bodies of the sick. Among discharges it is proper to treat as infective are those which come in cases of small-pox from the affected skin; in cases of cholera and enteric fever from the intestinal canal; in enteric fever also the urine; in cases of diphtheria and scarlatina from the nose and throat; likewise, in cases of any eruptive or other epidemic fever, the general exhalations of the sick. The caution which is necessary with regard to such matters must, of course, extend to whatever is imbued with them; care must be taken that the bedding, clothing, towels, handkerchiefs, and other articles which have been in use by the sick may not become sources of mischief, either in

the house to which they belong or in houses to which they are conveyed. So far as articles of this class can be replaced by rags or things of small value, it is best to use such things and burn them when they are soiled. Otherwise clothing and infected articles should be subjected to the disinfectant of the sick-room before washing, or be removed for disinfection by steam heat.

"In enteric fever and cholera the evacuations should be regarded as capable of communicating an infectious quality to any nightsoil with which they are mingled in privies, drains, or cesspools; and after such disinfection of them as is practicable, they should be disposed of without delay and under the safest conditions that local circumstances permit. They should not be thrown into any fixed privy receptacle, and, above all, they must never be cast where they can run or soak into sources of drinking water.

"Persons in attendance on the sick should exercise extreme personal cleanliness. In particular they should be careful, after touching the sick, or handling soiled clothes or other infectious matters, always to wash their hands in water containing a disinfectant before preparing or partaking of food.

"8. In the event of death taking place from an infectious disease, the body should as soon as possible be placed in a coffin with chlorinated lime or other suitable disinfectant, and should be buried (or cremated) with no longer delay than is necessary to allow the fact of death to be verified. Holding of "wakes," large funeral assemblages, and exposure of the corpse to visitors, are especially to be avoided, as is also borrowing of mourning dress for the occasion of the funeral.

"9. The washing and lime-whiting of uncleanly premises, especially of such as are densely occupied, should be pressed with all practicable despatch.

"10. Wherever there is stink, accumulation of house refuse or of other decaying animal or vegetable matter, or lodgment of foul liquid, the nuisance should as promptly as possible be abated, and precaution should be taken not to let it recur. Especially examination should be made as to the efficient working of sewers and drains, and any defect therein, and any nuisance therefrom or from any foul ditches or ponds should be got rid of without delay. The ventilation of sewers, the ventilation and trapping of house drains, and the disconnection of cistern overflows and sink pipes from drains should be carefully seen to. The scavenging of the district, the cleanliness of the surface of the ground, and the state of receptacles for excrement and of ashpits or dust-

bins will require close attention. In slaughter-houses, and wherever animals are kept, strict cleanliness should be enforced. The complete removal of stable manure and other similar refuse from the neighbourhood of dwellings at intervals never exceeding a week, will tend to prevent the propagation of flies, and thus diminish risk of the carriage of infection by these insects.

"11. In the removal of filth during periods of epidemic disease, it is commonly desirable to employ chemical agents for reducing or removing the offence and harm which may be involved in the disturbance of the filth. In the removal of privy contents these agents are more particularly needed if the disease in question be cholera or enteric fever. The chemical agent should be used liberally over all exposed surfaces from which filth has been removed. Unpaved earth close to dwellings, if it be sodden with slops or filth, ought to be treated in the same way.

"12. Source of water supply should be well examined. Water from sources which can be in any way tainted by animal refuse, especially those into which there may be any leakage from sewers, drains, cesspools, or foul ditches, ought no longer to be drunk. Above all, where the disease is cholera, diarrhœa, or enteric fever, it is essential that no impure water be drunk.

"The liability of leaky water-pipes to act as land drains and to receive foul matters as well as land drainage through their leaks is not to be overlooked. And such leaky pipes, running full of water with considerable velocity are liable to receive, by lateral insuction at their points of leakage, external matters that may be dangerous. This latter fact is not recognised so generally as it should be; and ignorance of it has probably baffled many inquiries in cases where water services have in truth been the means of spreading disease.

"If, unfortunately, the only water which can be got is open to suspicion of dangerous organic impurity, it ought at least to be boiled before it is used for drinking. It should not be drunk later than 24 hours after it has been boiled. Domestic filters of the type hitherto generally employed cannot be trusted to purify water. It cannot be too distinctly understood that dangerous qualities of water are not obviated by the addition of wine or spirits.

"13. When there appears any probable relation between the distribution of disease and of milk supplies, the cleanliness of dairies, the purity of the water used in them, the health of the persons employed about them, and the health of the cows that

furnish milk should always be carefully investigated. Even apart from any apprehension of milk being concerned in a particular outbreak of disease, it is desirable that English people should adopt the custom, which is always followed in some continental countries, of boiling all milk at once upon its reception into a house, unless, indeed, such milk has been previously sterilised.

"14. In certain cases special medical arrangements are necessary. For instance, as cases of cholera in this country sometimes begin somewhat gradually in the comparatively tractable form of what is called "premonitory diarrhœa," it is essential that, where cholera has appeared, arrangements should be made for affording medical relief without delay to persons attacked, even slightly, with looseness of bowels. So, again, where small-pox is the prevailing disease, it is essential that all unvaccinated persons (unless they previously have had small-pox) should very promptly be vaccinated; and that re-vaccination should be performed in cases properly requiring it.

"15. It is always to be desired that the people should, as far as possible, know what real precautions they can take against the disease which threatens them, what vigilance is needful with regard to its early symptoms, and what (if any) special arrangements have been made for giving medical assistance within the district. For the purpose of such information, printed hand-bills or placards may usefully be employed, and in cases where danger is great, house-to-house visitation by discreet and competent persons may be of the utmost service, both in quieting unreasonable alarm and in leading or assisting the less educated and the destitute parts of the population to do what is needful for safety; as well as in the discovery of unreported or suspicious cases of illness.

"16. Privation, as predisposing to disease, may require special measures of relief.

"17. The present memorandum relates to occasions of emergency. Therefore the measures suggested in it are essentially of an extemporaneous kind; and permanent provisions for securing the public health have, in express terms, been but little insisted on. It is to be remembered, however, that in proportion as a district is habitually well cared for by its Local Authority, the more formidable emergencies of epidemic disease are not likely to arise in it.

"18. Provision by the Local Authority for disinfection by steam of bulky articles, and of those which cannot without

injury be boiled in water or exposed to chemical agencies, ought always to be in readiness. Without such provision no complete disinfection of such articles can be effected. Partial and nominal disinfection, besides being wasteful, may be mischievous, as giving rise to a false security.

"19. The following system of domestic disinfection may be commended to Local Authorities who have already provided adequate public means for the disinfection and for the disposal of infected matters and things :—

"(*a*) For the purposes of the sick-room, such as the reception of soiled handkerchiefs, sheets, and the like, as well as for the swabbing of floors, a valuable disinfecting solution may be made with perchloride of mercury. It is well to have this solution slightly acid, coloured also in such a way that it shall not readily be confused with drinks or medicines ; and proper caution should be given to avoid accidents in its use. Local Authorities will find it advantageous to have such a solution* prepared and issued under the direct instructions of the Medical Officer of Health, and supplied of a uniform strength at the infected house upon the order of that officer. After being steeped in such solution and thoroughly well rinsed, linen and other washable articles should be washed in boiling water.

"(*b*) In places provided with a water-closet system of excrement disposal, excrements of cholera and enteric fever patients, after being treated in detail with the same disinfecting solution in ample quantity, may be safely put into the ordinary closet ; but house drains should be well flushed. Where privies or pail-closets are in use, the best arrangement for the disposal of infected stools that under the local circumstances may be found

"* Solutions fitted for the desired purposes are :—

"(1) ½ oz. corrosive sublimate, 1 fluid oz. hydrochloric acid, and 5 grains of commercial aniline blue, in 3 gallons (a bucketful) of common water. It ought not to cost more than 3d. the bucketful, and should not be further diluted. The use of non-metallic vessels (wooden or earthenware house tubs or buckets) should be enjoined on those who receive it, and articles that have been soaked in it should be set to soak in common water for some hours before they go to the wash.

"(2) Chlorinated lime (bleaching powder) in water, of the strength of 1 part in 100 = 1 lb. to 10 gallons of water.

"(3) Formalin—a solution of formic aldehyde gas in water. This may be used diluted in the proportion of 1 part of formalin to 50 parts of water. It is more expensive than the two preceding solutions, but has the advantage of being less corrosive, and less likely to injure articles with which it comes in contact.

"(4) Carbolic acid, or other effective coal-tar preparations, diluted respectively to an appropriate strength may also be employed.

practicable will have to be adopted—*e.g.*, special pails, furnished with tight-fitting lids and painted a distinguishing colour, may be furnished and collected daily by the Local Authority; their contents being then mingled with sawdust and burnt in a furnace.

"(*c*) The interiors of infected rooms should be disinfected by skilled persons acting under the directions of the Medical Officer of Health. Gaseous disinfection by means of sulphurous acid gas, chlorine gas, or formic aldehyde gas is commonly employed; but inasmuch as the infection which has to be destroyed is not that in the air of the room, but that clinging as dust and dirt to the surface and recesses of walls, floor, ceiling, and furniture, the use of these gaseous disinfectants may, with advantage, be replaced by the spraying upon the surfaces to be disinfected of a liquid disinfectant such as one or other of the solutions mentioned in the note to paragraph (*a*).

"(*d*) After measures of disinfecting a room have been taken, the wall paper, if soiled, torn or loose, should be stripped from the walls and be burned, and the room should have its ceilings and walls thoroughly washed or lime whited. The floor and woodwork should also be well washed with soap and water.

"20. For detailed information on hospital accommodation, on small-pox, and on questions of school administration during the prevalence of infectious disease, *see* the Office Memoranda on these subjects.

"ARTHUR NEWSHOLME,
"Medical Officer

"Local Government Board,
"Medical Department,
"*November*, 1909."

Special Preventive Measures for Various Diseases.

So far, we have been considering the question of prevention from a general standpoint; we must now apply the principles laid down to each of the more common infectious diseases, and in order to do so it is necessary to go somewhat into detail concerning the characteristics of each, not from the point of view of diagnosis or treatment—questions with which medical men alone have to deal—but simply in order to make intelligible the reasons for the precautions recommended in each case.

First, then, with regard to **quarantine** and **isolation.** As already

stated (p. 202), the duration of each is regulated by the **period of incubation** and the **period of infection.**

The following are the periods of quarantine and isolation recommended :—

	Quarantine to be Required after Last Exposure to Infection.	Shortest Period of Isolation after an Attack.
Small-pox, ...	16 days.	6 weeks.
Chicken-pox, . . .	20 ,,	3 ,,
Scarlet fever, . . .	10 ,,	6 ,,
Diphtheria, ...	After 3 negative swabs.	4 ,,
Measles, ...	16 days.	3 ,,
German measles, . . .	20 ,,	3 ,,
Whooping-cough, . . .	21 ,,	6 ,,
Mumps, ...	24 ,,	4 ,,
Enteric fever, . . .	21 ,,	4 ,,
Typhus fever, . . .	21 ,,	4 ,,

The quarantine figures (excepting enteric and typhus) are those suggested by the Association of Medical Officers of Schools ; those in the second column cannot be regarded as fixed and absolute under all circumstances. In the case of scarlet fever, for example, although "peeling" is no longer looked upon by most authorities as being important from an infectious point of view, until all throat, nose, or ear symptoms have disappeared, the danger of infection is not over, and these may continue for a longer period than six weeks. Neither in the case of small-pox is the limit a safe one. In fact, it is not wise to be guided by a hard and fast rule ; in some cases the period specified may be needlessly long, while in others it may not be long enough ; the question can only be definitely settled by the medical man in attendance.

With the medical treatment of infectious cases, as already stated, we have nothing whatever to do, but a knowledge of the special features of each, so far as they affect the management from a preventive point of view, must not be overlooked.

Small-pox, although still a much dreaded disease, has lost many of its terrors since the introduction of vaccination, and those who select to avail themselves of that protective measure, provided re-vaccination is not neglected, can afford to view exposure to infection with little or no dread of evil consequences.

The period of incubation, when the disease is contracted in the ordinary way by infection, is probably about twelve days, and within two days of attack the characteristic rash makes its appearance. The disease is infectious from the earliest period of its manifestation, probably by the breath, and danger exists during the whole course of its progress, but particularly so after the pustular stage, when the scabs begin to separate. Danger is not over until all the scabs have separated; in mild cases this may happen in about three weeks, but in others isolation may be necessary for six weeks, or even longer. In most cases probably the virus is inhaled, but in this, as in other infectious diseases, it is possible food may be the vehicle. It is believed by some that the infection may be conveyed by the air considerable distances further than is the case with other infectious diseases, a circumstance which, if true, would, of course, have an important bearing on the position of small-pox hospitals. This view, however, is by no means generally accepted, although up to a point there may be greater risk of transmission by air in the case of small-pox than some other infectious ailments.

In the management of small-pox cases, the free ventilation by open windows should never be omitted, and all the excretions and discharges from the patient ought to be disinfected, either by burning, or by the addition of a 1 per cent. solution of corrosive sublimate—this strength is necessary because of the diluting effect of the material to which it is added (see p. 222)—or any other efficient disinfectant previously mentioned, for example, "formalin" or "izal." Only old pieces of linen, or other suitable material that may be burned, should be used for the discharges, and all dirty linen, sheets, etc., should be saturated with corrosive sublimate solution, 1 part per 1,000, or the other disinfectants named in the strengths recommended. During the separation of the scabs, the application of vaseline or olive oil will diminish the chance of the infectious particles being scattered in the atmosphere, but it is doubtful whether a disinfectant can be used in this way in such quantity as will serve any useful purpose, the oil simply acts mechanically in preventing the drying of the scabs.

On the termination of the illness, the room must be disinfected by the methods already described (p. 224). The great preventives, however, against small-pox are **vaccination** and **re-vaccination.** No one ought to be allowed to nurse a patient who has not either had the disease or been successfully re-vaccinated, and when an outbreak occurs, all persons over ten years ought to be re-

vaccinated, and no delay should take place in the vaccination of children however young. All persons, whether exposed to infection or not, ought to be re-vaccinated after the age of twelve.

People, also, who have not been successfully vaccinated or re-vaccinated, and who may have contracted the disease, may suffer from a greatly modified attack, if indeed it is not entirely arrested, provided they are vaccinated within three days, or even as late as the fifth or sixth day, after exposure to infection ; the earlier the operation is performed the better. The reason of this is that the short period of incubation in the case of vaccination enables the effect on the system to be produced before the onset of the malady itself. Strange to say, notwithstanding the overwhelming evidence in favour of the efficacy of vaccination, people are still met with who profess not to believe in it. Some time ago the question was investigated by a special commission, who reported very strongly in favour of vaccination and made several most valuable recommendations, unfortunately, however, the legislation which followed came very far short of these recommendations, and there is serious reason to fear that the consequences will be disastrous.

POST-VACCINAL SMALL-POX MORTALITY.

Cases of Small-pox Classified according to the Vaccination Marks.	Number of Deaths per cent. in each Class respectively.
Unvaccinated, ...	$35\frac{1}{2}$
(1) Stated to have been vaccinated but having *no* cicatrix,	$21\frac{3}{4}$
(2) Having *one* vaccine cicatrix, ...	$7\frac{1}{2}$
(3) Having *two* vaccine cicatrices, ...	$4\frac{1}{3}$
(4) Having *three* vaccine cicatrices, ...	$1\frac{3}{4}$
(5) Having *four* or more vaccine cicatrices, . . .	$\frac{3}{4}$

Innumerable statistics might be brought forward in support of vaccination, but the foregoing figures, the outcome of twenty-five years' observation by Mr. Marson, in 6,000 cases of post-vaccinal small-pox in the London Small-pox Hospital, ought to satisfy all whose minds are not prejudiced.

It is evident from these figures that, up to a certain point, the protection afforded by vaccination is in accordance with the number of cicatrices, a fact which ought to be impressed upon

parents (especially mothers), who do their utmost to limit the operation to one, or at most two marks.

Chicken-pox is a disease which attacks persons of all ages, but more especially children. It is not a serious ailment, and in itself it is rarely, perhaps never, fatal. The period of incubation is about a fortnight, and the infection probably is communicated by the breath of patients. The disease is highly infectious, but, owing to its trivial character, disinfection is not usually practised.

Scarlatina or **scarlet fever,** which are one and the same disease, has already been commented upon, so far as its causation is concerned, in discussing the connection between certain diseases of the infectious class in man and animals (p. 200), but as yet no mention has been made of the risk to which the public are exposed, of infection being conveyed by milk directly contaminated by a scarlatinal patient. That such may happen in this, as in other infectious diseases, notably enteric fever, is unquestionable, and it behoves all those who are responsible for the public safety, to bear the fact in mind in their endeavours to arrive at the origin of such outbreaks.

A little advice to Sanitary Authorities on this subject may not be out of place. Milk sellers are specially apt to conceal the fact of the existence of infectious cases on their premises, or among persons they employ, as they are well aware that the law imposes certain conditions (see Appendix) with regard to the conduct of their business under such circumstances, and these must necessarily interfere with trade. When a culpable disregard of those conditions is clearly brought home to any individual, it is the imperative duty of the Authority to prosecute the offender, not so much with the view of inflicting a penalty, but rather as an example to other offenders.

By far the most frequent cause of scarlatinal infection, however, is from person to person, through neglect of precautionary measures, particularly in mild epidemics of the disease. Children run about the streets when actually suffering from the disease, convalescents are taken about the country in public conveyances, and by rail, before the risk of infection is over, infected clothing and other articles are recklessly sent to the laundry; in fact, the channels by which infection may be distributed broadcast among the people are endless, and yet the responsible authorities in many cases do not even provide the necessary appliances for disinfection. It is hardly reasonable to look for assistance from the public when their appointed guardians are so neglectful of the most ordinary precautions.

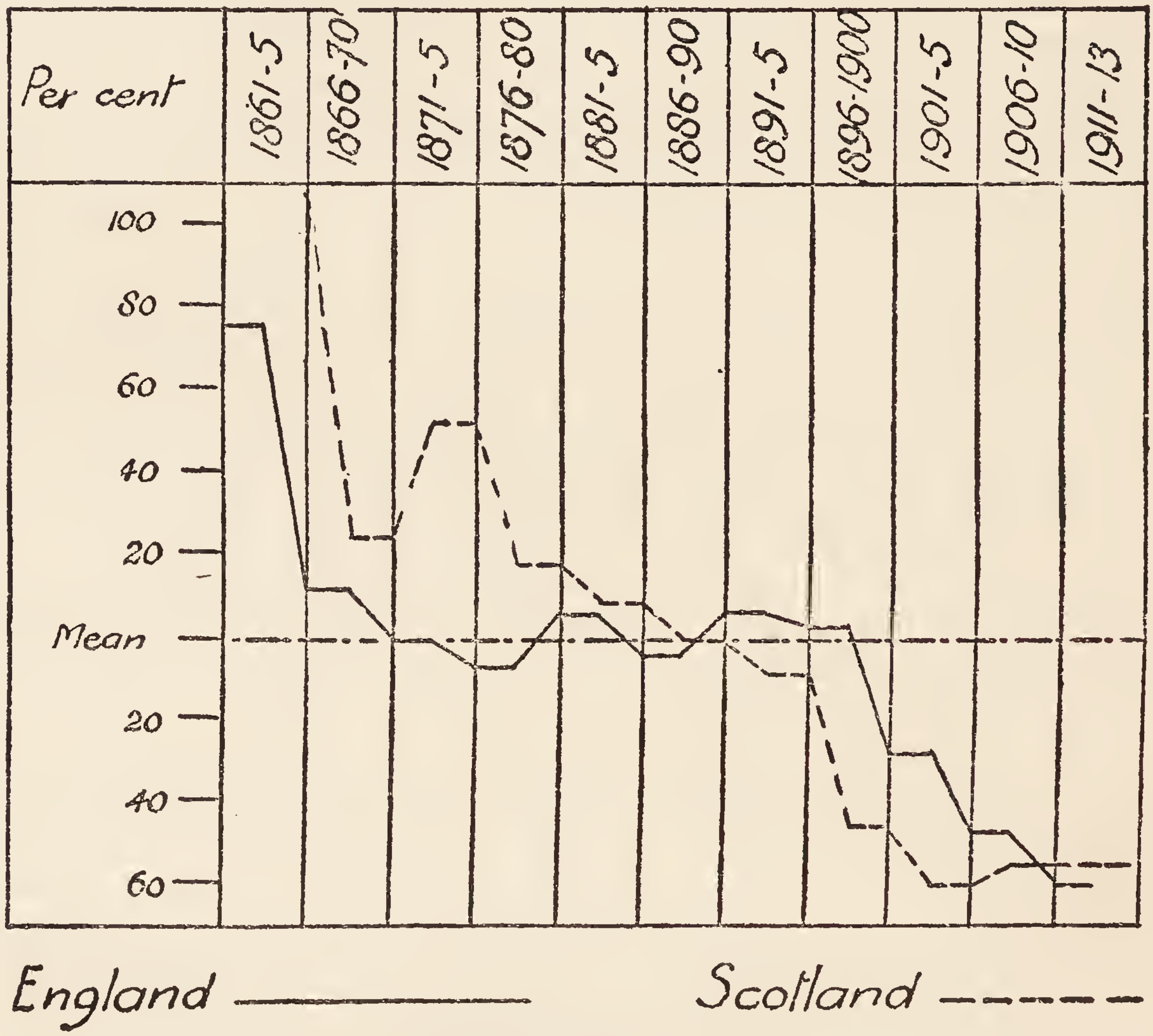
The incubation period of scarlet fever is by no means defined; it is usually three or four days, but it may be as short as one day, or as long as seven. The rash appears about twenty-four hours after the attack. The disease is infectious throughout its acute stage and until the throat symptoms disappear. The infectious stage is also prolonged until all signs of nose and ear trouble, if present, disappear, but, as already stated, less importance is now attached to desquamation (peeling) as a source of infection. The contagion does not seem to be conveyed long distances by the atmosphere, as some believe is the case with small-pox, although of this we have no absolute proof, but, as already pointed out, infected articles or rooms may remain so for long periods if not freely exposed to the air, or disinfected by other means. The infection is given off by the breath, and by discharges from the throat, nose, and ears. The precautions to be observed as regards the patient, clothing, etc., and the room are similar to those recommended in the case of small-pox.

Diphtheria, which is still a very fatal disease notwithstanding improved methods of treatment, causes considerable anxiety to the sanitary officer. Its origin is difficult to trace, but when once introduced into a district it spreads rapidly by personal contact, especially in schools, also by means of "carriers," and it may retain its hold in a district for many months. Evidence points to disturbance of polluted soil as having been a predisposing factor in some outbreaks.

It is a remarkable fact that, while improved sanitation resulted in lowered mortality rates from other zymotic disease, for a considerable time the reverse was the case as regards diphtheria. Coincident with this rise in diphtheria mortality, however, school attendance became compulsory in England, and in all probability to that cause alone was the temporary rise in mortality attributable. A comparison between the Scotch and English figures, which, through the kindness of the Registrar General for Scotland in supplying him with the needful data, the author has been able to make, bears this out in a very striking manner, as the diagram shows. It will be noticed that, while in Scotland, where practically every child attended school voluntarily for generations, there was a steady fall in diphtheria mortality in each quinquennial period with one exception from 1861 to 1913, the English rate, which had steadily fallen to below the mean in the period 1876-80, rose, and was maintained above the mean until the period ending 1900. Coincident with the rise education became compulsory in England by the coming into operation

of the Education Act, and the consequent bringing of the child population into intimate contact in schools in numbers which progressed as school facilities increased.

Recently the mortality from diphtheria has considerably declined, but to what extent this is attributable to improved sanitary conditions it is difficult to say, because coincident with the improved death-rate a new method of treatment has been



Diphtheria Diagram.

introduced which has greatly lowered the case mortality—namely, anti-toxin serum injections. Not only has anti-toxin serum proved to be most valuable as a curative agent, but its value as a prophylactic for a limited period has been conclusively demonstrated. Most sanitary authorities throughout the country now recognise this, and have made provision for the free supply of anti-diphtheritic serum for both curative and preventive purposes to those who cannot afford to pay for such treatment.

The period of incubation of diphtheria is probably from three

to five days, but cases occur which point to its development almost immediately after exposure to the infection, and, on the other hand, it may be prolonged for even a fortnight. The details of preventive measures to be observed, in addition to serum injections, are similar to those recommended in the case of small-pox, particular attention being paid to the discharges from the throat and nose, and also to the clothing and bedding.

Children from infected houses must be kept from school, and in rural districts those living in villages where the disease is prevalent, whether living in infected houses or not, ought to remain at home. On the other hand, if the disease prevails generally throughout a district, the schools ought to be closed for a period, and during this time, they should be cleansed and disinfected, a precaution which in all cases ought to follow the closure of schools on account of infectious disease.

Cerebro-spinal fever, a specific inflammatory affection of the brain and spinal cord, was, together with poliomyelitis (a disease which resembles it as regards symptoms), made compulsorarily notifiable in 1912. It is a disease which periodically makes its appearance in this country, although not to the same extent as in America and Continental Europe, the favourable time of year being winter and spring. The majority of cases occur among children, and the mortality is very high, frequently exceeding 50 per cent. of the cases.

From the fact that usually only one case occurs in a family, the disease cannot be said to be highly infectious, still, having regard to its deadly character, it is essential that no effort be spared to safeguard others. The specific organism of the disease (meningo-coccus) no doubt enters by the nose, as it is to be found in the excretion of the nose and pharynx, as well as in the cerebro-spinal fluid. Also, there may be "carrier" cases, as the organism has been formed in the air passages of healthy persons who have been in contact with cases. The disease is usually associated with overcrowding, and lack of cleanliness and ventilation.

The precautions to be adopted are the following :—

1. In localities where cases occur particular attention should be paid to all acute troubles of the nervous system, otherwise it is extremely likely that cases of true cerebro-spinal fever may be overlooked.

2. Cases should immediately be isolated in a special ward of an isolation hospital, if accessible, and if not, in a house in the neighbourhood temporarily acquired for the purpose.

3. All throat secretions, rags, towels, handkerchiefs, feeding utensils, etc., must be disinfected, and when the sick room is vacated, it, as well as the clothing and bedding, must be disinfected.

4. "Contacts" should be kept under observation for, say, thirty days, although the duration of infection and the incubation period are doubtful.

5. When cerebro-spinal fever is present in a locality, special efforts should be made to secure as cleanly surroundings as possible, and people should be encouraged to keep their windows open. In the case of "contacts" especially, the nearest approach to an open-air life should be aimed at.

An anti-toxin serum is now available for this disease also, which, when injected into the spinal canal, is very efficacious.

Measles, as already pointed out (p. 203), is a disease which is most fatal in childhood, and more especially so among children of the poorer classes, although in this respect it is not peculiar. The incubation period is about twelve days, and it is highly infectious from the first onset, before the characteristic rash makes its appearance, and before the nature of the malady is apparent. For this reason, and also because parents usually neglect all precautions to shield others from attack, when once the disease makes its appearance in a district probably few susceptible persons escape. Isolation of cases on a large scale has, so far, never been practised, but the closure of the infant departments of schools at any rate is a wise precaution to take. Apart from the usual precautions of isolation and disinfection, no special preventive measures are indicated in the case of this disease.

German measles (*Rotheln*) is an affection accompanied by a rash which resembles that of measles, although it is quite a distinct disease. It is rarely fatal, and it is not highly infectious.

Whooping-cough is a disease from which people of all ages may suffer, but it is far more fatal among infants than among other children and adults. Its general prevalence, when once it appears in a district, is to be attributed to its highly infectious character, and to the reckless manner in which children are taken about, even to public places, while suffering from it. Neither water, milk, nor other food seem to be responsible for its transmission, but it is readily communicated from person to person by the air, and probably the contagion may be conveyed considerable distances in this manner, as well as by articles of clothing, etc.

Isolation ought to be practised, and also disinfection of the

expectoration and vomit of patients, and of the sick-room on the termination of the illness. The period of incubation is about a fortnight, and the infectious period continues throughout the attack, and until the characteristic cough ceases, which may not be for two months, or even longer.

Mumps is a non-fatal but highly infectious disease, the contagion of which is conveyed by the breath of patients. It has an incubation period of about a fortnight, and from three to four weeks' isolation is all that is necessary.

Enteric fever (typhoid) is the disease *par excellence* of insanitary conditions, but that such in themselves, without the introduction of a specific virus, can give rise to it, is, to say the least, improbable. Highly polluted water may be consumed for long periods; houses with every possible defect as regards drainage, standing on land saturated with filth, and situated in crowded and dirty neighbourhoods, may be occupied for long periods with impunity so far as this disease is concerned, however much health may suffer in other respects; but given the introduction of a case of typhoid into a locality where all or any of these conditions are present, and its spread is certain. The fact that it is not always possible to trace an outbreak to an antecedent case, in an isolated locality, where the movements of the people are known might point to the possible origin *de novo* of the disease. On the other hand, as an argument against this, possibly a case so mild in character as not to have been recognised may have been imported, or the infection may have been conveyed by a "carrier," as will presently be discussed. Again, until we are familiar with the conditions upon which the development of the virus depends, judging from what we do know concerning the life-history of some micro-organisms, and how their growth may be interfered with, while their vitality is not destroyed, by a few degrees difference in temperature, for example, it is impossible to deny that the typhoid germ may lie dormant for long periods until circumstances favour its renewed vitality. Granting such a possibility, there need be no limit to the interval between two or more outbreaks of the disease, consequent upon one original importation.*

As regard "carrier" cases, it has now been proved beyond doubt that persons who at one time or other have suffered from the disease may, although apparently perfectly well, continue to

* See a paper by the author entitled "An Outbreak of Enteric Fever apparently traced to an antecedent case after an interval of twelve months." *British Medical Journal*, April 2nd, 1892.

be a source of great danger to others, owing to the survival and continued reproduction of the specific organism in their bodies and its discharge in their excretions. A good many outbreaks have now been traced to this cause in this and other countries, and indeed, given the possibility of such survival of the organism, it is not difficult to understand, disgusting though the idea is, how readily the poison may be spread broadcast through the channel of food and especially milk. It has been estimated that from 2 to 4 per cent. of persons who recover from enteric fever continue for indefinite periods to be carriers of the disease, and this being the case it is no longer difficult to account for the practically constant prevalence of the disease among armies in the field. By what process the disease breaks out among healthy men encamped in open country has hitherto been a mystery, but now there is no need to look far for an explanation, for, amongst a large body of men, the chances are that there will be one or more carriers, and the conditions of camp life, given the presence of a carrier, are obviously favourable to the spread of the disease.

The great source of danger lies in the fæces and urine, hence the risk that attends leaking drains and cesspools, and previous wells, and hence the reason why water, directly, or indirectly through the medium of a milk-supply, is so frequently the cause of typhoid being distributed broadcast among a community. Another potent cause of spread is the distribution of the poison in the form of dust, and its conveyance to food from infected accumulations in privies or by flies.

The points to attend to, then, in the management of cases, are scrupulous cleanliness and thorough disinfection of the discharges. Nurses, for example, must be careful, in handling food of any description, to see that their hands are clean, otherwise the poison may be conveyed in that way. No typhoid stools should be thrown into a privy, or discharged into a cesspool, and, until they have been disinfected in the manner recommended in the case of small-pox discharges (see p. 238), they ought not to be discharged into any drain. The best method of getting rid of such discharges in country districts is to bury them (after disinfection) a good depth in the ground, at a site far removed from any water-supply.

These precautions must be continued until convalescence is established, and the stools have acquired their natural appearance.

From what has been said, it will be understood that in all outbreaks of typhoid the existence of antecedent cases ought to

be enquired into, not forgetting the possible association with a carrier. The sanitary conditions should be carefully investigated, in relation to the house, its surroundings, and its water-supply. It is important to ascertain, in the absence of any local cause to which the origin may without doubt be attributed, whether the patients have previously been in any locality where cases have occurred, and in forming an opinion regarding this, one must be guided by the period of incubation, which varies from two or three days up to three or perhaps four weeks, although the usual period is from twelve to fourteen days. Lastly, the milk-supply must be enquired into. This may involve a considerable amount of trouble, for if it does not come direct from a dairy-farm, it has to be traced from thence through the milk-seller, and all the possible risks to which it may have been exposed during storage and distribution, and the existence of other cases that may be connected with it, must carefully be noted.

In view of the success obtained in the Army by preventive inoculation, this measure should not be overlooked if an epidemic threatens, in addition to taking rigorous measures to correct any sanitary defects.

Typhus Fever.—The prominent features of this disease are (1) it is conveyed by lice and is associated with dirt, poverty, and distress, and (2) the ease with which it may be prevented by cleanliness and ventilation.

The contagion, although very virulent in close proximity to the patient, soon loses its virulence when dispersed in the atmosphere. For this reason, in addition to isolation, quarantine, and disinfection, the necessity for free ventilation of the sick-room which applies to all infectious cases is more than ever indicated, and hence it is that the improved condition of dwellings has practically abolished the disease from the category of English epidemics. It is true that cases do occur in cleanly well-to-do households, but never, probably, except from direct contact with a previous case. From analogy, we may conclude that typhus fever is the outcome of the introduction into the system of a specific germ, but experience shows that insanitary conditions must co-exist, although, probably, in themselves they cannot give rise to the disease.

The period of incubation is by no means defined, and is probably dependent upon the amount of concentration of the poison. Twelve days is perhaps the usual duration, although, possibly, it may be as short as a few hours, or as long as three weeks. The fever runs its course usually in about a fortnight. Infection is

given off by the breath, by exhalation from the body, and possibly by the excreta.

Remembering what preventive measures have been recommended in other infectious diseases, those applicable in this disease will be apparent from the above description, but the all-important considerations are cleanliness and fresh air.

Relapsing fever closely resembles typhus as regards its causation and prevention, and not infrequently both diseases occur simultaneously. It is not often met with in England, but in Scotland, and still more in Ireland, epidemics are less infrequent.

Diarrhœa is a symptom which accompanies a variety of ailments, but the name is also used to designate an affection, which, from its frequent occurrence in epidemic form, is classed among the zymotic diseases. This disease, which is so fatal among young children, occurs during the summer and autumn, and, to whatever cause its origin may be attributed, its prevalance is undoubtedly governed by temperature ; it also would appear that those districts, in which sanitary observances receive least attention, suffer most. In recent years, since sanitation has come more to the front, the diarrhœa death-rate has greatly fallen, and no doubt a still further reduction may be effected by continued efforts to improve the dwellings and surroundings of the poor. It has been truly said, that one of the best tests of the sanitary state of a district is its infant death-rate, first, because the statistics, being calculated upon the births, are not dependent upon what may be a mistaken estimate of the population, and secondly, because infants are, as a rule, more susceptible to diseases that specially arise from insanitary surroundings.

It rests with Sanitary Authorities to see that children are wholesomely housed, but as predisposing causes, ignorance and neglect on the part of parents have also to be dealt with. If by some process it could suddenly be made apparent to mothers that milk is a food upon which children can live and thrive, and that fresh air, warmth, and cleanliness are essential to child life, at one stroke thousands of lives might be saved. This cannot suddenly be brought about, but may it not be achieved gradually through education—not by adding to the already congested condition of the educational standard, but by substituting for some of the more fancy subjects of the present school curriculum, a branch of instruction in popular hygiene?

Food, and especially milk contamination through the agency of flies, is one of the most potent causes of the disease, hence the importance of efficient refuse removal at short intervals, for it is in such rubbish that flies breed, and the keeping of food in covered vessels.

The practice of mothers going to work and leaving their children to the care of others, cannot conduce to their welfare, and it has been suggested that the legislature might step in and make it compulsory for the mother to remain at home with her child for a longer time after its birth than a month, which, at present, is the time specified in the Factory Act; whether such a course is feasible—there is no doubt about its being desirable—others must determine.

Cholera, which is rarely absent in some parts of India, and which has occurred in epidemic form in this country on four occasions since 1831 (the last being in 1865-6 when 5,548 deaths were attributed to it in London, and 14,378 in England), is a disease which is undoubtedly associated with insanitary surroundings. It resembles enteric fever in the manner in which it is propagated, the discharges from patients being, in all probability, alone responsible, and the chief mode of origin is through specifically contaminated water or food.

Granting, then, that a district is supplied with water from a pure source, that it is not liable to pollution, either during storage or distribution, and provided the dwellings are in every respect wholesome from a sanitary point of view, an imported case of cholera need not give rise to any undue alarm, provided every precaution as regards disinfection, etc., as laid down in the case of enteric fever, is observed.

The following official memorandum, dated August 25th, 1892, which was framed by Sir R. Thorne Thorne, late Medical Officer to the Local Government Board, is given *in extenso*, as it indicates so clearly the risks attending the disease, and the precautionary measures that are necessary :—

"1. The Order of the Local Government Board of July 12th, 1890, now in force, gives certain special powers to port and riparian Sanitary Authorities, enabling them to deal with any cases of cholera brought into their districts, so as to prevent, as far as possible, the spread of disease into the country. But it is to be remembered that cases of choleraic infection differ widely in severity, and that persons suffering only slightly from the disease, or incubating it, are likely to be landed at English seaboard and riparian towns, and to make their way to inland places. This has, in fact, occurred in former epidemics.*

* The Order here referred to has been rescinded, and, as the outcome of the International Sanitary Convention of Paris, 1903, a new Order, dated September 9th, 1907, is now in force.

"2. Former experience of cholera in England justifies a belief that the presence of imported cases of the disease at various spots in the country will not be capable of causing much injury to the population, if the places receiving the infection have had the advantage of proper sanitary administration; and, in order that all local populations may make their self-defence as effective as they can, it will be well for them to have regard to the present state of knowledge concerning the mode in which epidemics of cholera (at least in this country) are produced.

"3. Cholera in England shows itself so little contagious, in the sense in which small-pox and scarlatina are commonly called contagious, that, if reasonable care be taken where it is present, there is almost no risk that the disease will spread to persons who nurse and otherwise attend closely on the sick. But cholera has a certain peculiar infectiveness of its own, which, *where local conditions assist*, can operate with terrible force, and at considerable distances from the sick. It is characteristic of cholera (and as much so of slight cases where diarrhœa is the only symptom, as of the disease in its more developed and alarming forms), that *the matters which the patient discharges from his stomach and bowels are infective.* Probably, under ordinary circumstances, the patient has no power of infecting other person except by means of these discharges; nor any power of infecting even by them, except in so far as these matters are enabled to taint the food, water, or air which people consume. Thus, when a case of cholera is imported into any place, the disease is not likely to spread unless in proportion as it finds locally open to it, certain facilities for spreading by *indirect infection.*

"4. In order to rightly appreciate what these facilities must be, the following conditions have to be borne in mind—first, that any choleraic discharge, cast without previous thorough disinfection into any cesspool or drain, or other depository or conduit for filth, is able to infect the excremental matters with which it there mingles, and probably, more or less, the effluvia which those matters evolve; secondly, that the infective power of choleraic discharges attaches to whatever bedding, clothing, towels, and like things have been imbued with them, and renders these things, if not thoroughly disinfected, capable of spreading the disease in places to which they are sent for washing or other purposes; thirdly, that if, by leakage or soakage from cesspools or drains, or through reckless casting out of slops and wash-water, any taint (however small) of the infective material gets

access to wells or other sources of drinking water, it imparts to enormous volumes of water the power of propagating the disease. When due regard is had to these possibilities of direct infection, there will be no difficulty in understanding that even a single case of cholera, perhaps of the slightest degree, and perhaps quite unsuspected in his neighbourhood, may, *if local circumstances co-operate,* exert a terribly infective power on considerable masses of population.

" 5. The dangers which have to be guarded against as favouring the spread of cholera infection are particularly two. First, and above all, there is the danger of water supplies which are in any (even the slightest) degree tainted by house refuse or other like kinds of filth ; as where there is outflow, leakage or filtration from sewers, house-drains, privies, cesspools, foul ditches, or the like, into springs, streams, wells, or reservoirs, from which the supply of water is drawn, or into the soil in which the wells are situate ; a danger which may exist on a small scale (but perhaps often repeated in the same district) at the pump or dip-well of a private house, or, on a large or even vast scale, in the case of public water works. And secondly, there is the danger of breathing air which is foul with effluvia from the same source of impurity.

" 6. Information as to the high degree in which those two dangers affect the public health in ordinary times, and as to the special importance which attaches to them at times when any diarrhœal infection is likely to be introduced, has now for so many years been before the public, that the improved systems of refuse removal and water-supply, by which those dangers are permanently obviated for large populations, and also the minor structural improvements by which separate households are secured against them, ought long ago to have come into universal use.

" So far, however, as this wiser course has not been adopted in any sanitary district, security must, as far as practicable, be sought in measures of a temporary and palliative kind. (*a*) Immediate and searching examination of sources and conduits of water supply should be made in all cases where drinking water is in any degree open to the suspicion of impurity, and the water, both from private and public sources, should be examined. Where pollution is discovered, everything practicable should be done to prevent the pollution from continuing, or, if this object cannot be obtained, to prevent the water from being drunk. Cisterns should be cleaned, and any connections

of waste-pipes with drains should be severed. (*b*) Simultaneously, there should be immediate thorough removal of every sort of house refuse and other filth which has accumulated in neglected places; future accumulations of the same sort should be prevented; attention should be given to all defects of house-drains and sinks through which offensive smells can reach houses; thorough washing and lime-washing of uncleanly premises, especially of such as are densely occupied, should be practised again and again.

"7. It may fairly be believed that, in considerable parts of the country, conditions favourable to the spread of cholera are now less abundant than at any former time; and in this connection, the gratifying fact deserves to be recorded that during recent years, enteric fever, the disease which in its methods of extension bears the nearest resemblance to cholera, has continuously and notably declined in England. But it is certain that in many places such conditions are present as would, if cholera were introduced, assist in the spread of that disease. It is to be hoped that in all these cases the local sanitary authorities will at once do everything that can be done to put their districts into a wholesome state. Measures of cleanliness taken beforehand are of far more importance for the protection of a district against cholera than removal or disinfection of filth after the disease has actually made its appearance.

"8. It is important for the public very distinctly to remember, that pains taken and costs incurred for the purposes to which this memorandum refers cannot in any event be regarded as wasted. The local conditions which would enable cholera, if imported, to spread its infection in this country, are conditions which, day by day, in the absence of cholera, foster and spread other diseases, diseases which are never absent from the country, and are in the long run far more destructive than cholera. Hence the sanitary improvements which would justify a sense of security against any apprehended importation of cholera would to their extent, though cholera should never re-appear in England, give ample remunerative results in the prevention of other diseases."

As **yellow fever** and **malarial fevers** do not under ordinary circumstances occur in this country, their nature and prevention need not be considered. As regards the latter disease, however, the war has been responsible for the occurrence of cases in this country, and it has accordingly been added to the list of diseases compulsorily notifiable. This in all probability will prove to be a temporary imposition, as one may conclude that the

previous condition of practical immunity of the population will be restored.

Erysipelas, puerperal fever, and what is popularly known as **blood-poisoning,** are all diseases belonging to the infectious class, and each, no doubt, owes its origin to specific micro-organisms, which gain admission into the body either by means of surface abrasions or wounds, or by contact with some absorbent surface.

As these diseases are associated with dirt and insanitary conditions generally, their prevention can only be accomplished by careful attention to disinfection and cleanliness in all their details.

Hydrophobia is a fatal affection in man which results from the inoculation of the poison of the disease known as **rabies** in dogs and other animals. Till recently, when once the virus had undoubtedly gained admission into the system (many who are bitten through clothing do not contract the disease), death was looked upon as the only termination. Of recent years, however, owing to the labours of Pasteur, a remedy has been found in the shape of attenuated cultivations of the virus, which, when inoculated into an infected person, have the effect of greatly diminishing the risk of death, especially if the "vaccination" is performed soon after the accident. A series of vaccinations are necessary, highly attenuated virus being used at first, the virulence of the material being gradually increased with each successive operation, until at last the actual poison itself (obtained from the spinal cord of a rabid animal) is introduced. The efficacy of this treatment has been questioned, but careful inquiry has shown that the mortality from hydrophobia, which, in the absence of treatment, amounts to 15 per cent. of all persons bitten by rabid animals, is reduced by treatment to 1·36 per cent.*

By muzzling all dogs for a sufficient length of time it has been proved in this and other countries that the disease can be stamped out.

The period of incubation of hydrophobia is very variable; in some cases the disease manifests itself as early as one week after the introduction of the poison, but this is rare, six weeks being the usual interval, although it may be prolonged even to two years.

Tuberculosis must now be looked upon as an infectious disease from the fact of its proved connection with a specific organism. Heredity undoubtedly plays an important part in the production

* See Report by Special Committee appointed by the Local Government Board to inquire into M. Pasteur's treatment of Hydrophobia, presented in 1887. Also paper by Sir Victor Horsley (Secretary to the Committee) in the Epidemiological Society's Transactions, 1888-9.

of this as well as of other diseases, by the transmission of a constitutional peculiarity favourable to the development of the germs when they are introduced into the system.

The lungs are the organs most frequently affected, and **phthisis** or **consumption** is responsible for more than 80,000 deaths annually in the United Kingdom, or 11 out of every 100. But this by no means represents the sum total, for there are other tubercular affections that also contribute largely to the death-roll. Although for some time previously it had been suspected that consumption was caused by a micro-organism, it was not until 1882 that Koch published the results of his researches which established the parasitic nature of the disease.

Since then independent testimony has proved the accuracy of his conclusions, and now no one doubts that tubercular disease is associated with the introduction into the body of an extremely minute rod-shaped germ called the **tubercle bacillus.** As may be imagined, great results were anticipated from the discovery; it was hoped that it would prove to be the first step towards finding the specific for a disease which hitherto had been looked upon as incurable, but, alas, these expectations have not as yet been fulfilled. Many so-called remedies have been advocated from time to time. The most remarkable of these, for which Koch himself was responsible, was made public in 1890, and created even a greater sensation than the discovery of the *bacillus* itself. Unfortunately, owing to the publicity given to this supposed specific, and the exaggerated accounts of its value published in the lay press, combined with the secrecy which was at first observed concerning the nature of the remedy, thousands who had reconciled themselves to the fact that they were suffering from a fatal disease, were induced to hope that a specific had at last been discovered, a hope that was soon to be cruelly shattered.

It is well known that the treatment consists of repeated inoculations with a fluid specially prepared from cultivations of the tubercle bacillus; the details, however, need not here be discussed. This method of treatment, especially when it is employed during the earlier stages of the disease, has recently come more into favour, and the general establishment of tuberculosis dispensaries under the Insurance Act has afforded greater facilities for testing its value. It cannot yet be said, however, that its extended use has added to its reputation as a remedy, but until we have accumulated further evidence bearing upon its value as a curative agent it would be well to reserve

one's judgment and thus avoid forming an opinion on insufficient data.

It may be that some true preventive against tubercular disease will ultimately be discovered, but, in the meantime, previous failures in this direction must not be allowed to detract from the value of Koch's original discovery. Through it we have been enabled to prove that our previous suspicions regarding the infectiousness of tuberculosis were well founded, and the more precise knowledge which has thus been acquired has paved the way for more efficient steps being taken to limit the risk of the disease being conveyed from one person to another by means of infection. The fact that the germs of consumption are found in the air of rooms occupied by consumptive patients, indicates the risk that others run—at any rate those who are susceptible to the disease—in occupying the same room, and points to the necessity for precautions being taken in the shape of free ventilation and the disinfection of the sputum which is charged with the virus of the disease.

As in the case of other specific diseases there are many predisposing causes of consumption, the most important of which are dampness of locality, damp and ill-ventilated houses, overcrowding in houses and factories, and certain occupations, more especially those that are attended with the inhalation of irritating dust.

The discovery that dampness of soil predisposes to consumption and other tubercular affections was at first accidental, and arose out of the enquiry already referred to, which was conducted by Dr. Buchanan, as to the effect that general sanitary improvements in certain towns had had on the death-rates from diseases which are known to be influenced by insanitary conditions. The enquiry extended over a period of twenty years, in some cases longer. The table given on p. 4 is compiled from Dr. Buchanan's report, and columns 4 and 5 have reference to the question as regards phthisis. It will be seen that in nineteen instances out of the twenty-four more or less drying of the surface had followed the construction of sewers, and of these in no fewer than sixteen instances, the mortality from consumption showed a reduction varying from 49 to 1 per cent., the average being about 28. This led to a further enquiry on a comprehensive scale being made the following year (1867) into the influence of dampness of soil on consumption, and the following are the general conclusions resulting from it, based upon the ten years' returns (1851-60) :—

"1. Within the counties of Surrey, Kent and Sussex there is, broadly speaking, less phthisis among populations living on pervious soils than among populations living on impervious soils.

"2. Within the same counties there is less phthisis among populations living on high-lying pervious soils, than among populations living on low-lying pervious soils.

"3. Within the same counties there is less phthisis among populations living on sloping impervious soils, than among populations living on flat impervious soils.

"4. The connection between soil and phthisis has been established in this enquiry—

"(*a*) By the existence of general agreement in phthisis mortality between districts that have common geological and topographical features, of a nature to affect the water-holding quality of the soil.

"(*b*) By the existence of general disagreement between districts that are differently circumstanced in regard of such features; and

"(*c*) By the discovery of pretty regular concomitancy in the fluctuations of the two conditions, from much phthisis with much wetness of soil to little phthisis with little wetness of soil.

"But the connection between wet soil and phthisis came out last year in another way, which must here be recalled—

"(*d*) By the observation that phthisis had been greatly reduced in towns where the water of the soil had been artificially removed, and that it had not been reduced in other towns where the soil had not been dried.

"5. The whole of the foregoing conclusions combine into one —which may now be affirmed generally, and not only of particular districts—*that wetness of soil is a cause of phthisis to the population living upon it.*

"6. No other circumstances can be detected, after careful consideration of the materials accumulated during *this* year, that coincides on any large scale with the greater or less prevalence of phthisis, except the one condition of soil.

"7. In this year's enquiry, and in last year's also, single apparent exceptions to the general law have been detected. They are probably not altogether errors of fact or observation, but are indications of some other law in the background that we are not yet able to announce."

The conclusions exactly correspond with those arrived at by Dr. Bowditch, of Boston, U.S.A., upon very thorough investiga-

tion into one of the causes of consumption in Massachusetts, which is noticed in a report by the Registrar-General for Scotland written at the end of 1867, in which he refers to the mortality from consumption in the eight principal towns of Scotland as follows :—" Taking a five years' average (1857 to 1861 inclusive), it is found that supposing all these towns are brought to an uniform population of 100,000 persons, there died annually from consumption 206 persons in Leith, 298 in Edinburgh, 310 in Perth, 332 in Aberdeen, 340 in Dundee, 383 in Paisley, 390 in Glasgow, and 400 in Greenock. The fact is, that if each town had been arranged in the order of comparative dryness of its site, they would almost have arranged themselves in the above position—Leith and Edinburgh the most free from consumption, and also having the driest sites ; Glasgow and Greenock the most ravaged by that disease, and beyond all comparison situated on the dampest sites."

It is needless to point out that the above conclusions are of vital importance when considered in relation to the existence of weirs on rivers, especially in flat districts, as through them the subsoil water (see p. 15) is maintained at a height near the surface, to the detriment of the inhabitants of towns situated in the valley of the water-course.

The effect of **overcrowding**, as an exciting cause of consumption, is well shown by the various tables in the introductory chapter, but particularly by the figures in column 4 in the table on page 9.

Army and prison statistics also afford valuable evidence on this point, as by means of them a comparison can be drawn between the mortality among large bodies of men, similarly fed and clothed, but housed under different conditions. For example, in one prison in Vienna, " which was very badly ventilated," the deaths from consumption amounted to 51·4 per 1,000, during the years 1834-47. On the other hand, in a well-ventilated prison in the same town, during the years 1850-54, the deaths from this disease amounted to 7·9 per 1,000.

In a report to the Local Government Board by Dr. Barry and Mr. Gordon Smith, published in 1888, evidence is given as to the effect of back-to-back houses on the death-rates from lung diseases, including consumption, and also from diarrhœa.*

The effect of **occupation** on the death-rate from consumption is shown in the table on page 6. Those occupations in which

* This report is published by itself and does not appear in the Annual Report of the Medical Officer to the Local Government Board.

fine particles of sharp angular dust are inhaled are highly injurious, whereas equally dusty occupations, attended with the inhalation of smooth particles, such as coal dust, are far less so. This, probably, arises from injury to the lung tissue by the sharp particles leading to a chronic inflammatory condition which predisposes to the reception of the virus, whereas no such injury arises from the inhalation of smooth dust.

The dangers arising from the consumption of tuberculous meat and milk will be dealt with in the chapter devoted to unwholesome food.

From what has been said concerning the nature of consumption, the preventive precautions to be observed will be apparent; they need not therefore be gone into. The safety of others will best be secured by the free ventilation of rooms, and by forbidding healthy persons to occupy the same bedroom as the patient. The greatest care should be observed in dealing with the sputum; it ought either to be disinfected with solution of perchloride of mercury, or a 10 per cent. solution of carbolic acid, or, better still, rags may be freely used, and immediately burned. On no account must the expectoration be allowed to dry on the clothes, or on the floors, as the infective material will thus be scattered through the room.

When one sees the reckless way in which people expectorate in the streets, in public places, railway carriages, etc., and remembering the risk attending spray infection in coughing, one is not surprised to find that the presence of the tubercle bacillus is so frequently demonstrated when the air of public places is examined bacteriologically. Fortunately all persons are not equally susceptible to the disease, otherwise the consequences would be still more appalling than they are. It is the duty of all who are aware of the danger attending this practice never to allow an opportunity of remonstrating with such offenders to pass, and every Health Officer should do his utmost to encourage those who are suffering from the disease in the observance of the preventive precautions referred to above. Probably the task will too often prove a thankless one, but it is none the less our duty to undertake it.

Now that tuberculosis is a notifiable disease under the "Public Health (Tuberculosis) Regulations, 1912," it will be possible for authorities and their officers to exercise greater control over its spread than formerly was possible.

Compulsory Notification of Infectious Disease.

The Notification of Infectious Diseases Act is now compulsory throughout the country, and not only in the Metropolis, as was formerly the case. It is true that the great majority of Sanitary Authorities had already voluntarily availed themselves of the Act, but the short-sighted minority have now been compelled to come into line, and universal notification is an established fact.

The objection at first raised, that the Act, for a variety of reasons, would not work smoothly has been amply refuted, and that it has proved of the greatest service is unquestionable, even in districts where isolation hospital accommodation is not available. At the same time, full benefit can hardly be looked for from the Act unless means are provided for the early isolation of notified cases, and the disinfection of clothing, etc.

The general application of the Notification Act has undoubtedly added to the opportunities an Inspector has of imparting wholesome lessons among the people, and has correspondingly increased his responsibilities. While this is the case, it is to be feared that, for a time at any rate, he will have to bear the extra burden without any comparative increase in his salary, which at present, in too many instances, is miserably below what it should be. However, there are indications that better times are coming, and the greater the industry displayed by Inspectors in the conscientious discharge of their duties, the sooner will public opinion be influenced in their favour, and the sooner the justice of their claims will be recognised.

Duties of an Inspector during an Epidemic.—During an epidemic the sanitary inspector ought to be diligently occupied in attending to the work of disinfection, in visiting infected houses in order to caution the occupants against unnecessary intercourse with others, and in instructing the people how to use such disinfectants as are provided by order of the medical officer, and it is important that special attention should be paid at such times to all insanitary conditions. The practice of distributing bills with printed instructions, drawn out on not too elaborate a scale, is likely to be of service.

CHAPTER X.

FOOD.

It is not intended in this chapter to consider the question of our food supply, except in so far as it is important from a Sanitary Inspector's point of view, in relation to the duty that may be imposed upon him under the Public Health and other Acts (see Appendix). The purely medical aspect of the question, the elements essential to health, and the proportion, under varying circumstances, in which each should be present in our diet, does not specially concern him, and will not therefore be touched upon. Notwithstanding this limitation, however, the subject is one which ultimately concerns us all, especially in the light of modern experience, which tends more and more to establish a close relationship between diseases of animals and many of the ills that human flesh is heir to.

The Act empowers an inspector to examine "any animal, carcase, meat, poultry, game, flesh, fish, fruit, vegetables, corn, bread, flour, or milk exposed for sale, or deposited for the purpose of sale, or of preparation for sale, and intended for the food of man;" and it gives him power to seize the same if he finds that it is "diseased, unsound, or unwholesome." An inspector then must be familiar with the characteristics of sound and unsound food, so as to be able to detect that which is unwholesome, whether from disease or other causes.

It is obvious that this knowledge can only be acquired by experience, but unless he has some guide as to what he ought to look for, and some means of gauging the significance of what he sees, little progress will be made.

Meat may be unwholesome from a variety of causes. In all cases, a carcase, though free from disease, which shows evidence of decomposition, and in most cases the meat of animals that have suffered from disease, ought to be condemned as unfit for the food of man. Again, immature veal and lamb are considered unwholesome, and, undoubtedly, what is known as "slink" meat—that is, the meat of calves or lambs that have been cast prematurely, or have died during birth—should be condemned.

The meat of animals that have been "physicked" must be looked upon with suspicion, but the smell of physic, which may often be perceived in dead meat, and especially in the stomach, does not in itself afford sufficient grounds for seizure, although it indicates that all is not right, and warrants a more searching enquiry, with a view to the discovery of any diseased condition of the carcase that may account for the physicking, and possibly lead to its being condemned as unfit for food. The meat of animals that have not been killed, but have died, either from accident or illness, should be condemned, even although, as regards the latter, there is no distinct evidence of the nature of the malady. The meat of animals that have been slaughtered after injury need not be condemned, provided the health of the animal has not suffered in the interval, and the carcase has been perfectly bled. The fraudulent sale of the flesh of one animal, representing it to be that of another, is perhaps a more common practice than is generally supposed. The most common deception is the substitution of the flesh of the horse for that of the ox, and on the ground of health no objection can be raised to it. Indeed, an Act is in force (The Sale of Horse Flesh Act, see Appendix), which legalises the sale under certain restrictions, and in order to detect any infringement of this Act, the meat inspector should be able to distinguish the flesh of one animal from that of another. The flesh of dogs and cats is sometimes substituted for or mixed with pork and mutton in the manufacture of sausages and pies; as, under these circumstances, the meat is cut up into fine pieces, the detection of the fraud is hardly possible, and it concerns the police officer rather than the sanitary inspector.

Inspection of Live Animals.

Although an unhealthy animal intended to be used as food may be seized alive, it is not often that an inspector is called upon to pronounce upon such, and if he should be, it is not desirable for him to act on his own responsibility; the Medical Officer of Health ought invariably to be consulted in this, as in all doubtful cases, and it will probably be expedient to call in a veterinary surgeon. In order, however, that the initiative may be taken, it is well to be familiar with the ordinary signs of disease.

A healthy animal should be well nourished; its coat should be in good condition, not rough and standing; its skin supple,

and its flesh tolerably firm and elastic. It should not shiver, nor show any sign of being in pain; it should be able to get about without showing any indication of lameness, and to get up with ease. The eyes should be bright, the nostrils red and healthy looking, and, although moist, there should be no discharge from them; the tongue should not be hanging; and in the cow the teats should not be hot. An important indication of health is regular and easy breathing, and an absence of offensive odour in the breath.

Inspection of Meat.

The Carcase.—The inspector has a much better chance of forming an opinion regarding the quality of meat before it has been cut up, and the inspection, to be thorough, should include the various organs. Unless these are healthy, the butcher will carefully conceal them, so if the slaughtering has recently taken place, and they are not forthcoming, the probability is he has an excellent reason for their concealment.

A carcase should be thoroughly "set" in about twenty-four hours after slaughtering, or when it is quite cool, but this period varies in accordance with the temperature and moisture of the atmosphere, etc.; it should be well bled, free from bruises and bile stains, and one side or quarter should not differ from another, as regards colour. On applying pressure with the finger to the fleshy parts there should be no pitting nor crackling; the former indicates a dropsical condition, and the latter the presence of air within the tissues.

The appearance of the **interior of the chest** is of the utmost importance, especially if the lungs cannot be examined, as most diseases affecting these organs leave indelible traces on the interior of the chest walls. In a healthy animal these should be perfectly smooth, and the ribs, with the intervening fleshy parts, should be clearly seen through a transparent membrane. On the other hand, if the interior of the chest wall is very rough, and the lining membrane cloudy, the animal has probably suffered from an inflammatory affection, and the chances are that other signs of acute illness, sufficient to condemn it, will be found in the carcase. Butchers, as a rule, take care to remove, as far as possible, the evidence of such inflammatory mischief from the chest walls, but no amount of manipulation will restore the normal appearances sufficiently to deceive an ordinary skilled observer. By carefully removing all trace of the inner covering of the chest

(the pleura), the surface, after being exposed to the air, may not show much sign of having been interfered with, but if it be moistened with a damp cloth or sponge, the torn fibres will become opaque, and thus any doubt will at once be removed.

The lungs should be spongy, of a bright pink colour, and when cut into pieces each portion should float in water. The latter test, however, by no means proves that the lung is healthy, as it is only in advanced disease that the texture is so devoid of air as to cause it to sink in water. The lungs also should be free from cavities, matter (pus), and nodules.

The liver should be sufficiently firm not to break down easily on pressure; it should be of a dark brown colour and free from abscesses.

The stomach and bowels should be free from ulcers and all appearance of inflammation in the shape of blotchy redness, and they should not smell of drugs.

A more detailed description of the appearances to be looked for in the various organs will be found under the heading of the diseases that specially affect them.

Characteristics of Horse Flesh.—The sale of horse flesh, including the flesh of asses and mules, is permitted by law, provided the public are not deceived with regard to what they are purchasing (see Appendix). To guard against any such fraud, it is necessary that the meat inspector should be able to distinguish between the flesh of the horse and that of the ox. If the whole carcase can be inspected, the detection is a comparatively simple matter, but when the meat is cut up, especially if it has been boned, which is sometimes the case, it is not so easy.

The horse has eighteen **ribs** on each side, while the ox has only thirteen, and in the latter they are broader, flatter, and less arched, and are united to the cartilages by joints, while those of the horse have a fixed union.

The breastbone of the ox is flat above and below, while that of the horse is keel-shaped—that is, flat sideways. The bones of the horse are mostly larger than those of the ox, and they contain more fatty matter, which is of an oily consistence. Throughout the whole skeleton there are distinguishing features, although it is difficult to convey an idea of them in writing; an hour's study in a natural history museum, with the two skeletons side by side, will do more good than any description, however lengthy.

The tongue of the horse is broad at the point, while that of the ox is pointed, and the upper surface of the latter is rough,

and has a distinct prominence about mid-way between the root and the tip. If the bone of the tongue is examined in the ox, it will be found to consist of nine segments, whereas in the horse it is formed of five.

The liver of the ox forms one continuous mass, with one small segment or lobe at the upper and back part, and it has a gall-bladder attached. The liver of the horse, on the other hand, is formed of three large lobes and a small one, and it has no gall-bladder.

The heart of the ox is more conical or pear-shaped than that of the horse, and as a rule it has a larger deposit of fat on the surface, and this is paler and of a firmer consistency than that found on the horse's heart. In the base of the former there is a bone which is not found in the heart of the horse.

Horse flesh has a characteristic odour; it is darker, and has a coarser texture than beef, and there is little or no fat intermixed with its fibres.

The fat of a horse is very characteristic, so much so, that the butcher, if he wishes to deceive the public, removes the natural fat and substitutes that of the ox for it. It is darker and softer than ox fat, and has a peculiar flavour.

Characteristics of Good Meat.—Good meat should be firm and elastic to the touch, not doughy, and when pressure is applied by the finger it should not pit; after standing for a day or two, it should present a dry surface. The colour will vary according to the age of the animal; veal is quite pale in colour, and the flesh of an ox two or three years old is lighter in colour than that of an animal twice that age. Meat may either be too light or too dark in colour, as the result of disease; an exhausting illness, for example, may cause pallor, and the flesh of animals that have died with the blood in them will be dark, even purple; it will set badly and decompose readily. In both cases, however, other signs of disease will probably be found. Veins of fat should be intermixed with the flesh, so as to present a marbled appearance; there should be an absence of moisture, and on pressure no mucilaginous or mattery-looking fluid should exude from the tissue between the fleshy bundles (muscles), although on standing a thin, clear, red fluid may exude in small quantity.

The odour should be fresh, and by no means disagreeable, and if putrefaction has started, the nose will detect it long before any discoloration takes place. Early putrefaction is likely to be most apparent in the deeper parts, close to the bone, and it may be detected by introducing a knife and smelling it as soon as it

is withdrawn. Another means of bringing out any odour, is to bruise a piece of meat and pour hot water over it in a glass, which is then held close to the nose while the steam rises from it. As putrefaction advances, the meat softens and turns pale or livid, and at a later stage green. The earliest actual change in appearance, the result of putrefaction, is most likely to be found in the flanks, and in the marrow of the long bones ; the latter loses its pink salmony colour and solid consistency, and becomes soft and dirty looking. Fresh meat has a slightly acid reaction when tested with litmus paper, but when putrefaction is established the reaction is distinctly alkaline.

The fat should be white or straw-coloured, and show few blood spots. The fat of animals that are fed on oil cake is sometimes of rather a dark yellow colour, and the fat of Jersey and Guernsey cattle is darker naturally than that of other breeds.

Veal is paler in colour than beef, particularly if the animal has been bled before slaughtering—a common practice in the past, which happily is now seldom adopted—and both the flesh and fat are less firm than in the ox. In the immature calf the flesh is watery and has a distinctive odour.

Mutton is less florid in colour than beef, and the younger the animal, up to a certain point, the lighter the colour. The fat is white and very firm.

Pork is paler than mutton, although in this case also it is influenced by the age of the pig ; it is less firm, and the fat has a more oily or greasy consistency.

Meat Unfit for Human Food.

The meat of healthy animals may become unwholesome from putrefactive change, the result of being kept too long, or disease may render it unfit for food.

Putrid meat may give rise to very alarming and even fatal illness, particularly if, in the first instance, the animal has suffered from disease. It would appear, from the recorded investigations of such illnesses, that the cause may be attributed, either to the presence in the meat of minute organisms, or to an organic chemical poison resulting from putrefaction.

One of the most remarkable outbreaks of illness from this cause occurred at Welbeck in 1880, among persons attending the sale of the late Duke of Portland's effects. Dr. Ballard, who conducted the enquiry, found that seventy-two persons

were attacked by the disease, which proved fatal in four cases. The people were attacked with pain, intense diarrhœa, and symptoms of fever from twelve to thirty-six hours after luncheon. By a process of exclusion, it was found that the only articles partaken of which were open to suspicion as having produced the disease were sandwiches composed of beef and ham. Experiments conducted by Dr. Klein afterwards showed that the ham was infested with a special organism, numerous specimens of which were also found in the kidney of one of the patients who had died from the disease.* In addition to this, certain animals that were fed on, or inoculated with, portions of the suspected ham, were seized with a similar illness, which proved fatal to many of them; a like result also followed the inoculation of the organisms from the hams, after cultivation in the white of egg.†

Another outbreak very similar in character occurred at Nottingham in February, 1881. Dr. Ballard, who investigated this outbreak also, found that after eating baked pork, obtained from a certain shop, fifteen persons were attacked, and one died. Unfortunately, in this instance, none of the suspected pork could be obtained, but numerous organisms, similar to those associated with the Welbeck outbreak, were found in the body of the patient who died, and cultivations of them, inoculated into mice and guinea-pigs, gave rise to the disease in every instance.‡

In the same report in which the above history appears, the details of a fatal case of sausage poisoning at Arlford, which was investigated by Dr. Ballard, are given. Also in the "Report of the Medical Officer of the Local Government Board for 1887," an account is given by Mr. Spear of seventy cases of poisoning from pork-pie and brawn, which occurred at Retford, and proved fatal in one case.

In 1902 a serious outbreak occurred in Derby, which was investigated by Dr. Howarth, the Medical Officer of Health, and Prof. Delépine, and proved to be owing to a particular batch of pork pies sold by a pork butcher in that town. Upwards of 200 persons were known to have suffered, in some cases very severely, and in four cases death resulted.

* For an account of the organisms found, see *Micro-Organisms and Disease*, Klein.

† "Tenth Report of the Medical Officer of the Local Government Board," 1880.

‡ "Eleventh Report of the Medical Officer of the Local Government Board," 1881.

Although it would seem that pork is the meat to which poisonous symptoms are most usually attributed, both beef and veal may undoubtedly give rise to similar illnesses. With regard to venison and game, on the other hand, it is a remarkable fact, not easily accounted for, that both are habitually consumed in a state of decomposition, apparently with impunity.

Diseases of Animals in Relation to Food Supply.

The following are the diseases commonly met with that may affect, more or less, the quality of the meat :—Measles in pig and ox, trichinosis in pig, foot-and-mouth disease, pleuro-pneumonia, cattle-plague, pneumo-enteritis in pig, swine fever, puerperal fever, small-pox in sheep, rot in sheep, actinomycosis, anthrax, charbon symptomatique, tuberculosis, glanders and farcy in horses, and acute febrile disorders from various causes.

Measles (*bladder worm, Cysticercus cellulosæ*) is the term applied to a disease which occurs in pigs and oxen. It has absolutely nothing to do with the infectious disease of the same name in man, and is characterised by the existence of parasites in the muscles throughout the body. These parasites are enclosed in cysts or bladders, situated between the fibres of the muscles, and these are the larvæ of the human tape-worm. The species which affects the pig differs from that found in the ox, although the difference is not sufficiently marked to be apparent to the naked eye. The tape-worm which develops from each species also differs; that which occurs in the pig producing what is known as **Tænia solium,** while that found in the ox produces the **Tænia medio-canellata.**

The cysts may be seen by the naked eye; they are oval in shape, and vary in length from one-eighth to three-eighths of an inch; they are found in immense numbers everywhere throughout the muscular system, but more especially in the muscles of the tongue, the neck, the diaphragm and the shoulders; they may be found in the liver, kidney, heart, brain, and other organs and tissues.

If one of the bladders is removed and placed on a glass slide, it may be opened, when, with the aid of a good pocket lens, the worm will be seen within it. If examined under the low power of a microscope, a small depression will be seen at the apex of the head which is surrounded with hooklets.

The appearance of the flesh infected with these parasites has

given rise to the name measly; when cut in sections it is pale and flabby, and looks dropsical. Putrefaction commences early, and the flesh does not take on salt, but remains flabby after long curing. If the bladders have been in existence for a long period, they will have become chalky, in which case, on cutting through the flesh, a grating sensation will be imparted to the hand.

The life-history of these animals is as follows:—Each segment of the mature tape-worm which inhabits the human bowel contains thousands of eggs (it may be as many as 35,000); these segments are discharged from the bowel, and, in one way or another, the eggs are swallowed by the pig or ox, and are hatched within the animal. The embryo, when hatched, finds its way into the tissues of the animal by the aid of hooklets, six in number, placed round its mouth, and as soon as it has arrived at a favourable spot, it develops into the bladder form or cyst, which has just been described. In this position it remains during the lifetime of the animal, and when slaughtering takes place, and the flesh is consumed by the human subject, the parasite attaches itself to the bowel, and develops into the tape-worm, from the eggs of which it has sprung in the first instance.

During life, these cysts may be found by examining the under surface of the tongue, which is pulled out, and fixed with the aid of a piece of wood introduced crossways between the jaws.

Heat amounting to 170° F. destroys the parasite, so that infested pork, if thoroughly well cooked, may be consumed with impunity, but, as the cooking process may only be partial, and as the interior of a piece of meat is as likely to be affected as the surface, in order to avoid risk all such meat should be condemned.

Trichinosis is the term applied to an affection which occurs in the pig and in man, owing to the existence within the muscles of small thread-like worms. Unlike the cysticercus, which is found *between* the muscular fibres, the *Trichina spiralis*, as it is called, is enclosed in a much smaller oblong cyst *within* the muscular fibres themselves, although it would seem, they may be found in other tissues.*

Owing to the small size of the cysts within which the little worms live coiled up, they cannot so easily be seen as the cysticercus parasite, but, if present in large numbers, the naked eye can detect the speckled appearance presented by the flesh. To examine meat for trichinæ by the microscope, it is only necessary to use a low power. A thin section of the flesh is cut and placed

* *Lancet*, 23rd Sept. 1882.

upon a watch-glass containing a little solution of potash to disintegrate the muscular tissues, and it is then teased out by the aid of needles. If the cyst should be calcified, which is often the case, after washing with water, the addition of a little hydrochloric acid will soon clear it up, and the specimen can then be placed on a slide, under a cover glass, when the worm will readily be seen through the transparent cyst.

Although the parasites may be found in all parts of the muscular system, the favourite sites for them are in the muscles in the neighbourhood of the bowels—the diaphragm and abdominal muscles. It has been calculated that a cubic inch of flesh may contain as many as 100,000 parasites.

The male worm, when fully developed, measures $\frac{1}{18}$ inch, the female is much larger, measuring $\frac{1}{8}$ inch. The female contains from 500 to 600 eggs, and they are hatched within the body, so that the process of reproduction is *viviparous*. The recently-hatched worms pierce the bowels, and, travelling along, ultimately take up their abode in the muscles, where a cyst forms round each, the muscular fibres, in the meantime, having degenerated at the spot where the cyst forms. During the migration of these worms, the individual affected suffers from pains throughout the body, and is feverish, and if the infested meat has been consumed in a large quantity, the disease may prove fatal. After the worm becomes encysted, it remains quiescent in the muscle, and the symptoms subside.

It is supposed that the pig becomes trichinous from eating offal, and man contracts the disease from eating pork from trichinous pigs. The trichinæ, as they exist in flesh, are not readily destroyed, and if they have been encysted, say for twelve months, salting is quite inoperative against them. With regard to the effect of cooking, unless it is thorough, the vitality of the worms is not impaired by it, and it has been proved that they resist a temperature of 122° F. Imperfectly cooked food, therefore, is not safe, and all infested pork should be condemned.

Foot-and-mouth disease (*Eczema epizootica*) is a highly infectious malady, which attacks principally cattle, but sheep and pigs also suffer. As a rule it does not produce much constitutional disturbance, and as the internal organs and structures are not affected, the only signs of the disease in the carcase are to be found on the tongue and lining membrane of the mouth, between the claws of the hoof, and on the udder of cows. Blisters are found at these sites in the first instance, and these afterwards break and form ulcers. As the milk of cows suffering from the

disease may produce a similar affection in man, it ought to be condemned. It has not been proved that the flesh is injurious, and unless it has undergone a change from constitutional disturbance, it is doubtful whether it should be destroyed, although some authorities consider that it is wise to err on the safe side, and condemn it, on the ground that the animal has suffered from a general disease. There is no question with regard to the propriety of condemning those parts of the animal which are affected by the disease.

Pleuro-pneumonia is a contagious affection which specially attacks cattle, and, as its name implies, the parts affected are the lungs and the lining membrane of the chest (*Pleura*). Serious though the disease is, and great as are the changes produced within the chest, it is a remarkable fact that, as a rule, the carcase itself, as far as appearance goes, is unaltered, so that, unless the lungs or the walls of the chest are examined, no evidence of the disease will be found, provided the animal has been slaughtered. If, however, the animal is allowed to live until the disease is far advanced, the flesh may present a dark appearance, and the fat is tinted yellow from bile-staining. Of course, the butcher will take care to remove as far as possible all trace of the disease from the chest, but, if the lungs can be examined, they will be found to have lost their spongy character, and their surfaces, as well as the lining of the chest wall itself, will be thickened and rough. The lung substance in the early stage of the disease will present a grey appearance intermixed with red or purple patches, and in the later stages, a dark and marbled appearance. To the touch, it will be solid and resisting, and sections of the organ will be found to sink in water. The cavity of the chest will probably contain fluid.

If efforts have been made to conceal the disease by removing the pleura, the inspector will have little difficulty in detecting the fraud by remembering the instructions already given (see p. 262). It cannot be said that any injurious effects have been proved to result from this disease, still, as in the sale of such meat, an attempt is made to palm off upon the public as a sound article, that which is clearly not sound, reasonable grounds exist for condemning it.

Cattle-plague (*Rinderpest*).—This is a highly contagious and fatal disease, which is occasionally widely prevalent. The *post-mortem* signs in this case are to be found in the digestive tract, and in the skin. The flesh does not undergo a marked change, unless the malady has reached an advanced stage ; the mucous

covering of the bowel will be found to be congested, with extravasations of blood in patches, and, later on, more general inflammation, with ulcerations and hæmorrhages. Pustular sores may be found on the skin. If the disease has been well developed, the flesh will be dark and flabby, it will not set well, and it may crackle on pressure, owing to the tissues being infiltrated with air.

All authorities are agreed that the flesh of animals which have suffered from this disease ought to be condemned.

Pneumo-enteritis in the Pig (*Pig typhoid, hog cholera, red soldier, etc.*).—This is an infectious malady, which is rather common in England, and very fatal. The characteristic signs of the disease are usually to be found in the skin, the bowels, and the lungs. A patchy redness is usually found on the skin, hence the term "red soldier," or there may be livid blotches, when the disease is termed "blue soldier." Sometimes an eruption occurs resembling that of small-pox, with the secretion of matter, which afterwards forms scabs. The red patches referred to are not confined to the skin, but may extend to the fat beneath, in which case the butcher may attempt to disguise it by rubbing in salt along the cut edges, but by removing the edge with a knife, the fraud is at once exposed. It is not likely, however, if the skin is much affected, that the carcase will be exposed for sale.

Marked changes will be found in the bowel, particularly if the disease is advanced; signs of intense inflammation are present, and usually patches of ulceration (sores). The glands also within the abdomen will be enlarged, and fluid may be found in the cavity.

The lungs are usually congested or inflamed. As a rule the muscular system is not perceptibly altered, so that an examination of one portion of the carcase only may lead to the meat being passed as sound. In protracted and severe illness, on the other hand, the flesh may appear pale, flabby, and moist. Although it does not appear that the disease can be communicated to man, the meat of animals that have died from the disease, or been slaughtered while suffering from it, ought to be condemned.

Puerperal Fever (*Milk fever*).—This term is very loosely applied to all affections that cows suffer from after calving. With regard to the quality of the meat, it certainly ought to be condemned if the animal has been slaughtered while suffering from the disease. The signs of recent parturition will be apparent, or the tissues round the outlet of the pelvis may have been removed, in which case the existence of the disease may be suspected, in

the absence of any tissue change, such as congestion, moisture, and flabbiness.

If, from any physical cause, delivery cannot be accomplished, and the animal is slaughtered at an early stage, before any effect has been produced in the tissues, it is a question about which there is difference of opinion whether the meat should be condemned, although the general view is that it need not be.

Small-Pox in Sheep (*Variola*).—The cow, the horse, the sheep, and the pig are all liable to suffer from an affection which is termed variola or small-pox, but whether in all cases the disease is identical, is a question. In all, with the exception of the sheep, the disease is unimportant, but in that animal it is very malignant and fatal, and renders the meat quite unfit for food.

The chief feature of the disease is an eruption, which at first appears as red nodules, becoming afterwards watery vesicles, which in time contain matter (pus). Presently these break and discharge, forming scabs, which afterwards fall off. Apart from these signs, the carcase does not present very marked changes, except that the glands may be inflamed, and the flesh, if the animal has suffered severely, will have a disagreeable odour.

Rot in Sheep (*Liver rot, Flukes*).—This disease, which destroys an immense number of sheep annually, is caused by the presence of a worm (*Distoma hepaticum*) in the liver. This worm, which is shaped like a sole, and measures from an inch to an inch and a half in length, attaches itself to the bile-ducts within the liver, and ultimately chokes up the ducts and destroys the tissue. The eggs of the parasite are developed in ponds, in which the embryos (*Cercariæ*) swim about, and the sheep are supposed to take in the embryo with herbage. It then enters the liver, probably by the bile-ducts, and develops into the distoma.

The disease as regards man is unimportant, and if only a few flukes are found in the liver, that organ only need be destroyed. On the other hand, if the disease has led to tissue changes in the carcase, the meat should be condemned.

Actinomycosis is a disease which specially affects the ox, although it is probable the horse and the pig also suffer from it. The disease, which is produced by the "ray fungus" (*Actinomyces*), mostly attacks the tongue of the ox and immediately adjacent tissues, including the jaw, but it may invade other bones, and also the lungs. The fungus, in all probability, is introduced with the food, and on entering the tissues it sets up inflammation, and causes a deposit of fibrous tissue. The tongue is hard and dense (*wooden tongue*), and very much enlarged, so

much so that it may protrude some inches from the mouth ; on cutting into it, it presents a nodular appearance. When the disease occurs in the lung, it is apt to be mistaken for tuberculosis, which, to the naked eye, it closely resembles.

The disease does not, as a rule, produce fever or much constitutional disturbance, consequently the meat may not show any signs of having deteriorated in quality. Opinions differ with regard to the necessity for condemning such meat, although there is no question but that the affected organs should be condemned. According to Mr. Wynter Blyth the flesh of animals suffering from the disease, however healthy it may appear, is unfit for human food.

Anthrax (*Splenic fever*, and in man, *wool-sorter's disease*) is a most fatal disease which arises from the introduction into the body of a micro-organism (*Bacillus anthracis*). It commonly attacks oxen and sheep, but pigs also may be affected. The tissues of animals that have suffered, present swellings and tumours at various parts containing gelatinous matter, and decomposition sets in immediately after death, particularly in the regions where the swellings occur ; soon, also, the body of the animal becomes immensely swollen, from the formation of gas. The tissues are watery, the muscles are very friable, and of a dark red, or even black colour, from being stained by the blood, which is black and fluid. The spleen may be ruptured ; as a rule it is enormously enlarged ; it is black, and when divided an ink-black fluid runs from the cut surface. The heart-tissue is soft, and it, like the other organs, the liver, the kidneys, and the lungs, is congested.

The above are the usual *post-mortem* signs of anthrax, but there is another affection, popularly known as **black-leg,** or **quarter-ill** (from the fact that the disease is confined specially to one or other of the quarters), which is often described as being a form of anthrax, although it is unattended by enlargement of the spleen, or the fluid and black condition of the blood, and results from a micro-organism which differs in appearance from that of anthrax proper. The other signs of this disease in the carcase resemble those of anthrax. There is the same tendency to rapid putrefactive change, and the tissues are friable, moist, and doughy. The name given to this disease is **Charbon Symptomatique.***

* See "Thirteenth Annual Report of Medical Officer of the Local Government Board," 1883, "On the Etiology of Charbon Symptomatique," by G. F. Dowdeswell, M.A., F.L.S., F.C.S., etc.

The appearances presented by the carcase, both in the case of anthrax and charbon symptomatique, will at once indicate, even if the organs cannot be inspected, that the animal has suffered from a serious constitutional malady, and there is no question whatever but that the flesh should be unhesitatingly condemned.

Tuberculosis (*Consumption*).—The relationship that exists between this disease in man and animals has already been referred to in the chapter devoted to infectious disease. We have now only to consider the signs of the disease in the carcase, and the consideration which ought to weigh with one in determining whether the meat may safely be used for the food of man. Koch's views regarding the non-identity of human and bovine tuberculosis were never generally accepted, and they have now been disproved by the Royal Commission appointed to inquire into the question.*

The appearances presented differ at different stages of the malady. Rounded growths, at first hardly visible to the naked eye, form in the tissues and increase in size, until they approach that of a pigeon's egg, or even larger. This has given rise to the disease being known as "pearl disease," or the "grapes," among butchers. The favourite spot for the development of these, is on the surface of the lung and the walls of the chest, and they afterwards invade the interior of the lung, giving rise to an inflammatory condition of the organ. The little growths, on being cut into, have a yellow appearance, and cheesy consistency, although sometimes they are hard and gritty. As the disease advances, the lung is apt to break up, and abscesses may form in its substance. It does not follow, particularly in the early stages, that the carcase should be emaciated, although, as a rule, if marked evidence of the disease is present, the flesh is poor and lean.

Unless the inspector should come upon the scene early, he will probably find that efforts have been made to remove all trace of the disease, but a careful inspection of the chest walls, in the manner already described (p. 262), will reveal that they have been stripped of their internal covering, and the characteristic deposits or abscesses may be found in other organs or tissues of the body if careful search is made for them. In addition to the lungs, the most likely sites for the development of the tubercles, or pearls, are the glands in connection with the bowels, and the glands about the neck, but the liver, and other organs and tissues, may also be affected.

* Final Report, June, 1911.

Should Tubercular Meat be Condemned?—At present opinions differ somewhat regarding this important question. Some authorities say that the flesh of all animals suffering from tuberculosis, even if the disease is only slightly developed, and confined to the lungs, is unfit for food. Others maintain that one is not justified in condemning such meat, unless the local evidence of the disease, whether in the lungs or in other organs, is considerable, or when more general signs of the disease, however slight, are present. There are others who go the length of saying that such meat may be consumed with safety, however advanced and general the disease may be, provided the organs affected are discarded. The last opinion may be dismissed at once, as being reckless in the extreme.

As the outcome of a report of a Royal Commission on Tuberculosis which was presented in 1898, rigid and extreme condemnation of the meat of tuberculous animals, no matter how slight and localised the disease may be, is no longer followed, and a less stringent custom now prevails. This report is a most interesting and valuable document, and a memorandum of instructions based upon it has since been issued by the Local Government Board. The recommendations of the Commission, which are here reproduced *in extenso*, indicate very clearly the substance of the conclusions arrived at.

"A.—Slaughter-houses.

"1. We recommend that in all towns and municipal boroughs in England and Wales, and in Ireland, powers be conferred on the authorities similar to those conferred on Scottish corporations and municipalities by the Burgh Police (Scotland) Act, 1892, viz.:—

"(*a*) When the local authority in any town or urban district in England and Wales and Ireland have provided a public slaughter-house, power be conferred on them to declare that no other place within the town or borough shall be used for slaughtering, except that a period of *three* years be allowed to the owners of existing registered private slaughter-houses to apply their premises to other purposes. The term of *three* years to date, in those places where adequate public slaughter-houses already exist, from the public an-

nouncement by the local authority that the use of such public slaughter-houses is obligatory, or, in those places where public slaughter-houses have not been erected, from the public announcement by the local authority that tenders for their erection have been accepted.

"(*b*) That local authorities be empowered to require all meat slaughtered elsewhere than in a public slaughter-house, and brought into the district for sale, to be taken to a place or places where such meat may be inspected; and that local authorities be empowered to make a charge to cover the reasonable expenses attendant on such inspection.

"(*c*) That when a public slaughter-house has been established inspectors shall be engaged to inspect all animals immediately after slaughter, and stamp the joints of all carcases passed as sound.

"2. It appears desirable that in London the provision of public in substitution for private slaughter-houses should be considered in respect to the needs of London as a whole, and in determining their positions regard must be had for the convenient conveyance of animals by railway from the markets beyond the limits of London, as well as from the Islington market, to the public slaughter-houses which should be provided. At the present time no administrative authority has statutory power authorising it to provide public slaughter-houses other than for the slaughter of foreign cattle at the port of debarcation.

"3. With regard to slaughter-houses in rural districts, the case is not so easy to deal with. But the difficulty is one that must be faced, otherwise there will be a dangerous tendency to send unwholesome animals to be slaughtered and sold in small villages where they will escape inspection. We recommend, therefore, that in Great Britain the inspection of meat in rural districts be administered by the county councils. In Ireland the duty of carrying out inspection ought to devolve upon authorities corresponding as nearly as possible to those charged with that duty in England and Scotland. In view of the announced intention of the Government to introduce a new scheme of local government into Ireland we refrain from specifying the exact machinery which should be employed.

"4. We recommend further that it shall not be lawful to offer for sale the meat of any animal which has not been killed in a duly licensed slaughter-house

" B.—Qualifications of Meat Inspectors.

" 5. We recommend that in future no person be permitted to act as a meat inspector until he has passed a qualifying examination, before such authority as may be prescribed by the Local Government Board (or Board of Agriculture), on the following subjects :—

" (*a*) The law of meat inspection, and such bye-laws, regulations, etc., as may be in force at the time he presents himself for examination.
" (*b*) The names and situations of the organs of the body.
" (*c*) Signs of health and disease in animals destined for food, both when alive and after slaughter.
" (*d*) The appearance and character of fresh meat, organs, fat, and blood, and the conditions rendering them, or preparations from them, fit or unfit for human food.

" C.—Tuberculosis in Animals intended for Food.

" 6. We recommend that the Local Government Board be empowered to issue instructions from time to time for the guidance of meat inspectors, prescribing the degree of tubercular disease which, in the opinion of the Board, should cause a carcase, or part thereof, to be seized.

" Pending the issue of such instructions we are of opinion that the following principles should be observed in the inspection of tuberculous carcases of cattle :—

" (*a*) When there is a miliary tuberculosis of both lungs, . . " (*b*) When tuberculous lesions are present on the pleura and peritoneum, ... " (*c*) When tuberculous lesions are present in the muscular system, or in the lymphatic glands embedded in or between the muscles, . . " (*d*) When tuberculous lesions exist in any part of an emaciated carcase, ...	" The entire carcase and all the organs may be seized.

"(*a*) When the lesions are confined to the lungs and the thoracic lymphatic glands, . . .

"(*b*) When the lesions are confined to the liver, ...

"(*c*) When the lesions are confined to the pharyngeal lymphatic glands, . . .

"(*d*) When the lesions are confined to any combination of the foregoing, but are collectively small in extent, . .

"The carcase, if otherwise healthy, shall not be condemned, but every part of it containing tuberculous lesions shall be seized.

"In view of the greater tendency to generalisation of tuberculosis in the pig, we consider that the presence of tubercular deposit in any degree should involve seizure of the whole carcase and of the organs.

"In respect of foreign dead meat, seizure shall ensue in every case where the pleura have been 'stripped.'

"*April 4th,* 1898."

Attached to this report is a memorandum signed by three of the seven members of the Commission advocating the payment of compensation, under certain restrictions, to the owner of a confiscated carcase or part of a carcase.

Milk Unfit for Food.

Milk.—As already noticed, it is possible that milk may be the vehicle of contagion of certain infectious diseases, not only by the virus in question being introduced from an outside source, but also, because the cow may be suffering from a corresponding ailment. It is probable that scarlet fever, foot-and-mouth disease, and, possibly, diphtheria may thus be directly transmitted, although, in the case of scarlet fever as well as enteric fever the danger, as regards milk, is usually an indirect one, arising from its accidental contamination from an outside source.

It has also been proved that the milk of **tuberculous** cows may convey that disease both to animals and man.

The bacillus of tubercle has been found not only in the milk of cows suffering from tubercular affections of the udder, but also in the milk of tuberculous cows in whose udders no trace of the disease could be found, as well as in their fæces. This being the

case, such milk cannot be consumed with impunity, especially as the disease is so fatal among children, at an age when milk forms an important part of their diet. All risk may be avoided by boiling the milk, but cooking is not equally serviceable in the case of meat, as the temperature in the interior is not likely to be raised sufficiently to destroy the bacilli.

The final report of the Royal Commission on Tuberculosis, published in June, 1911, confirms and amplifies the conclusions of the previous interim reports. Although it would appear that there are slight cultural differences between the bovine and human tubercle bacillus, and although the cow is highly resistant to the human type of organism, it has been conclusively proved that the bovine bacillus gives rise to tubercular diseases in man and especially children, the form of the disease when so conveyed being usually glandular although it may become general.

In concluding their final report the Commissioners write :—

"Meanwhile we, in view of the evidence adduced by us, regard ourselves as called upon to pronounce on administrative measures required in the present for obtaining security against transmission of bovine tubercle bacilli by means of food. In the interests therefore of infants and children, the members of the population whom we have proved to be especially endangered, and for the reasonable safeguarding of the public health generally, we would urge that existing regulations and supervision of milk production and meat preparation be not relaxed; that on the contrary Government should cause to be enforced throughout the kingdom food regulations planned to afford better security against the infection of human beings through the medium of articles of diet derived from tuberculous animals.

"More particularly we would urge action in this sense in order to avert or minimise the present danger arising from the consumption of infected milk. And in this connection it may be convenient for us to repeat certain facts observed by us in reference to the conditions tending to the elimination by the cow of bovine tubercle bacilli in her milk; facts, in our opinion, of such importance that they formed the subject of our Third Interim Report.

"Bovine tubercle bacilli are apt to be abundantly present in milk as sold to the public when there is tuberculous disease of the udder of the cow from which it was obtained. This fact is, we believe, generally recognised though not adequately guarded against. But these bacilli may also be present in the milk of tuberculous cows presenting no evidence whatever of disease of

the udder, even when examined post-mortem. Further, the milk of tuberculous cows not containing bacilli as it leaves the udder may, and frequently does, become infective by being contaminated with the fæces or uterine discharges of such diseased animal. We are convinced that measures for securing the prevention of ingestion of living bovine tubercle bacilli with milk would greatly reduce the number of cases of abdominal and cervical gland tuberculosis in children, and that such measures should include the exclusion from the food supply of the milk of the recognisably tuberculous cow, irrespective of the site of the disease, whether in the udder or the internal organs."

An Order of the Board of Agriculture, which came into operation on May 1st, 1913 (now temporarily suspended), provides for the compulsory notification of suspected tuberculosis with emaciation in bovine animals and of tuberculosis of the udder, and for the payment of compensation for slaughter.

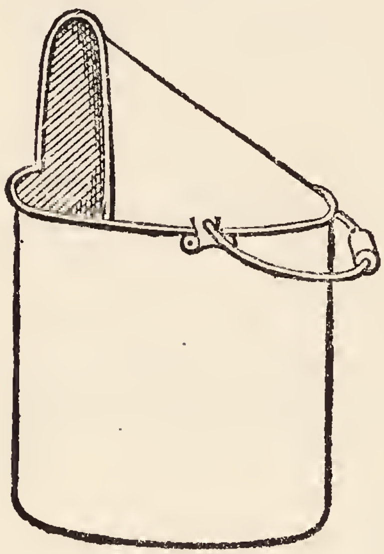


Fig. 108.

This was a step in the right direction, which was followed by the passing of the Milk and Dairies Act, 1914, the coming into operation of which was postponed by the Milk and Dairies Acts Postponement Act, 1915, which Act was subsequently repealed by the Milk and Dairies (Consolidation) Act, 1915, which comes into operation "on such date not being later than the expiration of one year after the termination of the present war as the Local Government Board (now Ministry of Health) may by order appoint" (see Appendix).

If, when this Act comes into operation, proper provision is made by the responsible authorities to insure its observance, very great benefit will undoubtedly result.

For many years past the question of improving the purity of the milk supply has engaged the attention of health authorities, and it would now appear that public opinion has been sufficiently roused to make milk purveyors themselves realise to some extent the importance of adopting more cleanly methods. Milk, as a general rule, contains an amount of dirt, which would startle consumers if they were aware of the fact, but, being an opaque fluid, the dirt it contains is obscured. Most of this dirt gains access to the milk during the process of milking, owing to the disturbance of caked manure on ungroomed cows, which falls directly

into the large open milking pail. Of course, the proper grooming of cows would greatly diminish this source of pollution, but, apart from that, it has been demonstrated that if milk producers in this country would adopt a type of milking can which is now extensively used in America, that expedient alone would be instrumental in excluding no less than 95 per cent. of dirt. This American milk can is shown in the drawing (Fig. 108), a glance at which will show why it is so efficient in protecting the milk from pollution. At first sight it might appear that the process of milking would be rendered difficult, owing to the hooded top, but, as a matter of fact, this is not so, as has been proved by practical working on a large scale in America, and on a lesser scale in this country.

Glanders and farcy are one and the same disease, apparently confined to horses and man. It is highly contagious, and may be communicated from the horse to man.

The signs of **glanders** are to be found in the membrane lining the cavity of the nose, which is ulcerated; in the glands under the jaw, which are enlarged; and the lungs, which are inflamed.

In farcy, one or more of the limbs are swollen, and nodular swellings (" buds "), the size of a marble, form under the skin in the course of the lymphatic glands. These, which contain a yellow fluid, ultimately burst, leaving inflamed open sores.

The flesh of horses that have suffered from the disease should undoubtedly be condemned.

Acute Febrile Disorders.—Only the more common ailments from which animals suffer have been noticed, but all affections of a febrile nature are likely to produce changes in the carcase that render it more or less unfit for human food. Any departure then from the normal appearances, even if there are no signs of specific disease to be found in the organs, must be viewed with suspicion.

Tinned Meat is responsible in many instances for serious, and sometimes fatal, illness. This may arise from the meat in the first instance having been diseased, but more frequently it is owing to putrefactive changes having taken place from imperfect preservation. Sometimes, also, poisonous metals are absorbed from the can or solder. In such cases the inspector is powerless until illness calls attention to them.

Putrefactive changes can be detected by examining the tin before it is opened. The pressure of the gases within causes the ends of the tin to bulge and become convex instead of concave, and on tapping, a drum like note is produced in place of a dull one. When the tin is opened the solder should not be seen to

project from the seams, and no erosion of the tin coating the iron of the case should be apparent. Sometimes the bright surface of the tin is tarnished owing to the heat in cooking, an appearance which is known as "can brown." Heavy blacking, on the other hand, is due to decomposition, and the consequent alkalinity, causing the coating of tin to be dissolved when the exposed iron of the can is attacked, giving rise to the black colour.

Practical experience necessary.—Book-knowledge is all very well in its way, but unless the meat-inspector takes the trouble to make himself practically acquainted with what he reads, he is certain to make mistakes. It is an easy matter to familiarise oneself with the appearances of sound meat, but this is not all that is necessary. No opportunity of acquiring a practical knowledge of the changes in the carcase, the result of disease, should be allowed to pass.

So long as the system of slaughtering animals in private slaughter-houses adjoining butchers' shops is general throughout the country, we must not expect that our food supply will receive that careful scrutiny which, it is daily becoming more apparent, it ought to. Neither is it possible under existing circumstances, except in the case of large towns, for the duty of meat-inspection to be entrusted to men specially trained in the work. In time, it is to be hoped, that private slaughter-houses will give place to public abattoirs, under the management of central controlling authorities, and then, properly trained inspectors may be appointed throughout the country, but, until then, the sanitary inspector will probably be held responsible.

Fish Unfit for Food.

Fish that has undergone putrefactive change may give rise to serious symptoms, and the least taint is sufficient to condemn it. The inspector will experience no difficulty in judging of its quality, the odour alone being sufficient to determine the point. The flesh ought to be firm, the eye bright and prominent, and the gills healthy-looking. Commencing putrefaction may readily be detected by applying the nose close to the open gills and mouth.

Certain kinds of fish, and more especially shell-fish, are more likely to give rise to serious symptoms than others. Many examples may be given, and a very striking one was reported by Sir C. Cameron in 1890. Seven persons were attacked about twenty minutes after having eaten stewed mussels, and the symptoms were vomiting, swelling of the face, spasms, etc.;

five of the cases were fatal, and the two persons who recovered had only partaken of a few of the mussels.*

The risk that enteric fever may be conveyed by shell fish has been conclusively proved by the publication of several well-authenticated cases. This will, it is to be hoped, lead to measures being taken to stop the practice of rearing oysters, or fattening them, in sewage-polluted estuaries and streams. The appearance of cholera in different parts of England has also been attributed to shell-fish from infected fishing towns.†

Vegetables and Fruit.

The signs of decay in fruit and vegetables are sufficiently apparent not to require description, and in condemning any which are decayed, the inspector must use his own judgment, or, if in doubt, appeal to the Medical Officer of Health for guidance. As a rule, the public are capable of protecting themselves.

The danger arising from the consumption of decayed fruit, in the case of young children, is a serious one, owing to the tendency it has to cause diarrhœa.

Corn, Bread, and Flour.

The question of the wholesomeness of corn, bread, or flour is one which must be decided by the Medical Officer of Health or analyst, but it is an inspector's duty to submit samples of any of these articles should he have reason to suspect that they are unsound or unwholesome.

* *British Medical Journal,* July 19th, 1890.

† Report by the Medical Officer of the Local Government Board on "Cholera in England during 1893."

APPENDIX.

THE PRINCIPAL STATUTES

AFFECTING THE

INSPECTOR OF NUISANCES.

SUMMARISED AND COLLATED.

INDEX OF STATUTES REFERRED TO.

Session and Chapter.	Short Title and Year.	Abbreviation.
10 and 11 Vict. c. 34,	Towns Improvement Clauses Act, 1847,	T.I.C.
10 and 11 Vict. c. 89,	Towns Police Clauses Act, 1847,	T.P.C.
38 and 39 Vict. c. 55,	Public Health Act, 1875,	P.H.A.
38 and 39 Vict. c. 63,	Sale of Food and Drugs Act, 1875,	F.D.
39 and 40 Vict. c. 75,	Rivers' Pollution Prevention Act, 1876,	R.P.
40 and 41 Vict. c. 60,	Canal Boats Act, 1877,	C.B.
41 and 42 Vict. c. 25,	Public Health (Water) Act, 1878,	P.H.W.
41 and 42 Vict. c. 74,	Contagious Diseases (Animals) Act, 1878,	C.D.A.
42 and 43 Vict. c. 30,	Sale of Food and Drugs Act, 1879,	F.D.
47 and 48 Vict. c. 75,	Canal Boats Act, 1884,	C.B.
48 and 49 Vict. c. 72,	Housing of the Working Classes Act, 1885,	H.W.C.
49 and 50 Vict. c. 32,	Contagious Diseases (Animals) Act, 1886,	C.D.A.
50 and 51 Vict. c. 19,	Quarry Fencing Act, 1887,	Q.
50 and 51 Vict. c. 29,	Margarine Act, 1887,	M
51 and 52 Vict. c. 41,	Local Government Act, 1888,	L.G.A.
52 and 53 Vict. c. 11,	Sale of Horseflesh Act, 1889,	H.
52 and 53 Vict. c. 72,	Infectious Diseases (Notification) Act, 1889,	I.D.N.
53 and 54 Vict. c. 34,	Infectious Diseases (Prevention) Act, 1890,	I.D.P.
53 and 54 Vict. c. 59,	Public Health Acts Amendment Act, 1890,	P.H.A.A.
53 and 54 Vict. c. 70,	Housing of the Working Classes Act, 1890,	H.W.C.
55 and 56 Vict. c. 62,	Shop Hours Act, 1892,	S.H.
56 and 57 Vict. c. 73,	Local Government Act, 1894,	L.G.A.
62 and 63 Vict. c. 51,	Sale of Food and Drugs Act, 1899,	F.D.
1 Edw. vii. c. 22,	Factory and Workshop Act, 1901,	F.
3 Edw. vii. c. 39,	Housing of the Working Classes Act, 1903,	H.W.C.
7 Edw. vii. c. 53,	Public Health Acts Amendment Act, 1907,	P.H.A.A.
9 Edw. vii. c. 44,	Housing, Town Planning, etc., Act, 1909,	H.T.P.A.
7 Edw. vii. c. 32,	Public Health (Regulations as to Food) Act, 1907,	
8 Edw. vii. c. 55,	Poisons and Pharmacy Act, 1908,	
1 and 2 Geo. v. c. 52,	Rag and Flock Act, 1911,	
3 and 4 Geo. v. c. 23,	Public Health (Prevention and Treatment of Disease) Act, 1913.	
5 and 6 Geo. v. c. 66,	Milk and Dairies (Consolidation) Act, 1915,	
5 and 6 Geo. v. c. 64,	Notification of Births (Extension) Act, 1915,	
8 and 9 Geo. v. c. 29,	Maternity and Child Welfare Act, 1918,	
9 and 10 Geo. v. c. 35,	Housing, Town Planning, etc., Act, 1919,	H.T.P.A.
	ALSO	
41 and 42 Vict. c. 52,	Public Health (Ireland) Act, 1878,	Ireland.
54 and 55 Vict. c. 76,	Public Health (London) Act, 1891,	London.
60 and 61 Vict. c. 38,	Public Health (Scotland) Act, 1897,	Scotland.

APPENDIX.

NOTE.—*In the following pages* MINISTRY OF HEALTH *must now be substituted for* LOCAL GOVERNMENT BOARD.

Introductory.

THERE are few tasks more difficult of performance than to present in an intelligible form a condensation of the Statutory Provisions upon any subject. The aim of this appendix is to provide candidates for the examinations in Sanitary Law with a guide to their more extended reading. It does not pretend to dispense with the need of a careful perusal of the Acts quoted, or with a reference to the reports published in the various Law Journals of the decided cases cited.

All reference to such cases has advisedly been omitted from this appendix which deals with the statutes only, leaving the direction as to their interpretation, as influenced by the decided cases, to the legal advisers of the authorities who have to administer them. At the same time, it will strengthen the position of the inspector to carry his study further, and, to keep himself up-to-date in this respect, he cannot do better that read *Knight's Medical Officers' Annual*, which contains all new statutes as well as orders and circular letters of the L.G.B., and references to decided cases. But, as a minimum, it is essential to the intelligent discharge of his duties that an inspector shall possess such a knowledge of the Acts of Parliament and Orders governing public health administration as will enable him to act discretely and avoid barking when he is not in a position to bite. As a matter of fact, an inspector who understands his business can generally get what he wants done by tactful persuasion, and he should only employ strong measures as a last resource, and when he has every reason to believe that the law will support his action. Experience will enable him to come to a wise decision under ordinary circumstances, but, if in doubt as to his position, he must not hesitate to consult the legal adviser of his authority before committing himself to a definite course of action, even in so far as his limited powers enable him to go. To assume an attitude which he cannot maintain damages his reputation and handicaps him in his future work.

The appendix deals solely with English law—*i.e.*, the Law of England and Wales—though a few remarks are added on the Law of Scotland and Ireland, so far as the main differences are concerned.

It is a matter of regret that we are still dependent on the Act of 1875, and that Parliament has never yet found time to codify and consolidate the various amending acts of the past forty years as has now to a large extent been done for the Metropolis, which will receive separate attention.

The following abbreviations are used :—M.O.H. = Medical Officer of Health ; L.G.B. = Local Government Board ; L.A. = Local Authority ; S.A. = Sanitary Authority ; S.I. = Sanitary Inspector.

The Local Government Board.

This Board (now the Ministry of Health), which governs the whole of local administration, both Sanitary and Poor-Law, in England and Wales, was created by special Act of Parliament in 1871, and was constituted as follows :—The President, to be appointed by the Sovereign, and the following *ex officio* members—that is to say, the Lord President of the Council, all the principal Secretaries of State for the time being, the Lord Privy Seal, and the Chancellor of the Exchequer. The President and one of the Secretaries are always Members of the House of Commons, and as was stated in the House in February, 1907, by Mr. John Burns, the Board had never met and never would if it could possibly be avoided ; the powers are vested in the President for the time being, and he can authorise the Secretary to act in his behalf.

The Board in reality is a staff of permanent officials controlled by the President, and divided into departments, the head of each department being responsible to the Permanent Secretary for those under him.

The departments are five in number, and are as follows :—

1. Poor Law Administration.
2. Public Health, Local Finance, and Local Acts.
3. Audit and Statistical, including Local Taxation.
4. Sanitary Administration and Local Areas.
5. Legal and Order Department.

The duties of the Board have gradually accumulated, many having been transferred to them from other departments—*e.g.*,

from the Privy Council. Among other duties, the Board prescribe from time to time the duties assigned to M.O.H. and S.I., from whom annual reports are required. In addition to this, they maintain a staff of travelling inspectors, who are sent all over the country to investigate special conditions affecting the Public Health, or to enquire into the proposed outlay by the S.A. of any sum of money (raised by loan) on public works.

These inspectorial visits are naturally occasions of anxiety to a local Sanitary Inspector, who should be prepared to show all his books, and be ready to give any particulars which may be required as to his district and its needs and condition.

Appointment of Inspector of Nuisances.

Every S.A., whether Urban or Rural, is required to appoint among other officers an inspector of nuisances, who may also be the surveyor (P.H.A., secs. 189, 190); further, a single inspector of nuisances may be appointed to more than one district with the consent of the L.G.B., who shall apportion the salary to be paid by each district.

Every Metropolitan S.A. shall appoint a sufficient number of fit and proper persons to act as "Sanitary Inspectors," a term which has replaced the title "Inspector of Nuisances" in London; and it is required that they shall hold a certificate of having passed such examination as the L.G.B. may from time to time approve (London, secs. 107, 108).

The duties of urban and rural inspectors of nuisances are identical, and are set out in detail in Article XX. of the General Order of the Local Government Board, published December 13th, 1910.

To facilitate reference this article is here set out in full:—

Duties of Inspector of Nuisances.

"Article XX.—The following shall be the duties of an Inspector of Nuisances as regards the District or part of the District for which he is appointed (in this Article referred to as 'his District'):—

"1. Subject to the directions of the Council, he shall perform, under the general supervision of the Medical Officer of Health, all the duties specially imposed upon an Inspector of Nuisances by the Public Health Act, 1875, or by any other Statute or Statutes, or by the Orders issued by Us, so far as the same apply to his office.

"2. He shall attend all meetings of the Council, or of Committees of the Council, when so required.

"3. He shall by inspection of his District, both systematically at certain periods, and at intervals as occasion may require, keep himself informed in respect of the nuisances existing therein that require abatement.

"4. On receiving notice of the existence of any nuisance within his District, or of the breach of any bye-laws or regulations made by the Council for the suppression of nuisances, he shall, as early as practicable, visit the spot, and inquire into such alleged nuisance or breach of bye-laws or regulations.

"5. He shall report to the Council any noxious or offensive businesses, trades, or manufactories established within his District, and the breach or non-observance of any bye-laws or regulations made in respect thereof.

"6. He shall report to the Council any damage done to any works of water supply, or other works belonging to them, and also any case of wilful or negligent waste of water supplied by them, or any fouling by gas, filth, or otherwise, of water used or intended to be used for domestic purposes.

"7. He shall from time to time, and forthwith upon complaint, visit and inspect the shops and places kept or used for the preparation or sale of butchers' meat, poultry, fish, fruit, vegetables, corn, bread, flour, milk, or any other article to which the provisions of the Public Health Acts in this behalf apply, and examine any animal, carcase, meat, poultry, game, flesh, fish, fruit, vegetables, corn, bread, flour, milk, or other article as aforesaid which may be therein; and in case any such article appear to him to be intended for the food of man, and to be unfit for such food, he shall cause the same to be seized, and take such other proceedings as may be necessary in order to have the same dealt with by a Justice. He shall also take such action as it may be necessary for him to take by virtue of the provisions of the Public Health (Regulations as to Food) Act, 1907, and any Regulations made thereunder: Provided that in any case of doubt arising under this paragraph, he shall report the matter to the Medical Officer of Health, with the view of obtaining his advice thereon.

"8. He shall, when and as directed by the Council, procure and submit samples of food, drink, or drugs suspected to be adulterated, to be analysed by the analyst appointed under the Sale of Food and Drugs Act, 1875, and upon receiving a certificate stating that the articles of food, drink, or drugs are adulterated, cause a complaint to be made, and take the other proceedings prescribed by that Act.

"9. He shall give immediate notice to the Medical Officer of Health of the occurrence within his District of any infectious or epidemic disease; and whenever it appears to him that the intervention of such Officer is necessary in consequence of the existence of any nuisance injurious to health, or of any overcrowding in a house, he shall forthwith inform the Medical Officer of Health thereof.

"10. He shall, subject to the directions of the Council, attend to the instructions of the Medical Officer of Health with respect to any measures which can be lawfully taken by an Inspector of Nuisances under the Public Health Act, 1875, or under any other Statute or Statutes, or under any Regulations issued by Us, for preventing the spread of any infectious or epidemic disease.

"11. He shall enter from day to day, in a book to be provided by the Council, particulars of his inspections and of the action taken by him in the execution of his duties. He shall also keep a book or books, to be provided by the Council, so arranged as to form, as far as possible, a continuous record of the sanitary condition of each of the premises in respect of which any action has been taken under the Public Health Act, 1875,

or under any other Statute or Statutes, or under any Regulations issued by Us, and shall keep any other systematic records that the Council may require.

"12. He shall at all reasonable times, when applied to by the Medical Officer of Health, produce to him his books, or any of them, and render to him such information as he may be able to furnish with respect to any matter to which the duties of Inspector of Nuisances relate.

"13. He shall, if directed by the Council to do so, superintend and see to the due execution of all works which may be undertaken under their direction for the suppression or removal of nuisances within his District.

"14. He shall, if directed by the Medical Officer of Health to do so, remove, or superintend the removal of, patients suffering from infectious disease to an infectious diseases hospital, and shall perform, or superintend, the work of disinfection after the occurrence of cases of infectious disease.

"15. He shall, if directed by the Council to do so, act as Officer of the Council as Local Authority under the Diseases of Animals Acts, 1894 to 1909, the Canal Boats Acts, 1877 and 1884, and under any Orders or Regulations made thereunder.

"16. He shall, as soon as practicable after the Thirty-first day of December in each year, furnish the Medical Officer of Health with a tabular statement containing the following particulars:—(*a*) The number and nature of inspections made by him during the year; (*b*) the number of notices served during the year, distinguishing statutory from informal notices; (*c*) the result of the service of such notices.

"17. In matters not specifically provided for in this Order, he shall observe and execute any orders and directions which may be hereafter issued by Us and the lawful orders and directions of the Council, applicable to his office."

Now that births are compulsorily notifiable under the Notification of Births (Extension) Act, 1915, as well as measles and German measles (first cases in a family) by Order of the L.G.B., 1st January, 1916, it follows that the appointment of health visitors will become general, and as part of the duties of such officers will be to note and report all insanitary conditions met with in the course of their routine visits, this will undoubtedly be the means of bringing to the notice of inspectors defects which otherwise might have escaped their notice or the notice of their assistants. This additional aid in discovering the existence of nuisances will be welcomed by all active inspectors.

In Scotland the duties are set out in the General Order made under the Scotch Act, in much the same terms, although in practice the departments of the M.O.H. and the inspector are much more distinct and less co-ordinated than in England.

In the Metropolis the duties are regulated by the Sanitary Officers (London) Order, 1891, and in this no mention is made of infectious diseases, or of waterworks and the fouling of water.

The Public Health Act, 1875.

In considering the provisions of this Act in detail, it is more convenient to omit reference for the moment to Part I., which contains the definition of terms hereafter employed, and to quote the definition of each term on its first occurrence in the body of the Act.

Part II. of the Act deals with the appointment of authorities for the purpose of carrying out the various powers conferred under the subsequent provisions, and comprises sections 5-12.

For administrative purposes the whole of England and Wales except the Metropolis (which at that time was governed by the various Metropolis Management Acts) was divided into two classes of authorities—Urban and Rural.

Urban Districts include—

1. Municipal Boroughs in which the S.A. consists of the Mayor, Alderman, and Councillors acting by the Council.

2. Districts which were then called "Improvement Act" districts or "Local Government" districts, but which, since the Local Government Act of 1894, sec. 21, are all called "Urban Sanitary Authorities."

Rural districts are any parts of a Poor Law Union not comprised in the neighbouring urban district. If in two counties it, as a rule, becomes two districts or more; the authority is the Rural District Council.

Another form of administrative authority is included in the Act (secs. 287-292) called a Port Sanitary Authority, and is created by order of the L.G.B.

Certain sanitary powers are exercised by the County Councils which were created by the Local Government Act, 1888, secs. 17-19; also they must now appoint M.Os.H., and in some cases a sanitary inspector has been appointed, but no special duties are assigned to him by statute.

The Metropolis, with which is now fully incorporated the district of Woolwich, is governed by the London County Council, and is now divided into Municipal Boroughs. The London Act of 1891, and the London Government Act of 1899, have replaced the Metropolis Management Act of 1855, and others.

In Scotland the administrative units are practically similar, though with different titles, and the arrangement of powers differs from the English system.

In Ireland there are also urban and rural districts, there being

71 of the former and 159 of the latter. These require no special notice in this work.

Another class of authorities was created by the Local Government Act of 1894, which provided for the management of smaller units than the ordinary district. The Parish Council, though not strictly a sanitary authority in the meaning of the principal Act, is entrusted with certain powers with regard to housing, water supply, etc., and may make representations to the County Council on sanitary defects. As, however, they have no control over the sanitary officers other than through the District Council, it is not necessary to enter into further details.

The sanitary provisions of the Act are set forth in Part III., and comprise sections 13-143, which must now be considered in detail.

Sewers and Drains form the subject of the first portion, and although much of the work in connection therewith necessarily belongs to the surveyor's department, there are also many points concerning which the inspector will be required to possess a working knowledge of the provisions of this and other Acts.

—"Drain," according to the definition clauses, means "any drain of and used for the drainage of one building only, or for premises within the same curtilage, and made merely for the purpose of communicating therefrom with a cesspool or other like receptacle for drainage, or with a sewer into which the drainage of two or more buildings or premises occupied by different persons is conveyed."

—"Sewer" includes sewers and drains of every description except drains to which the word "drain" as aforesaid applies, and except drains vested in or under the control of any authority having the management of roads, and not being a Local Authority under this Act. A County Council is an example of such an authority.

These definitions are taken from sec. 4, but a complication was introduced into them by the Act of 1890, which, in sec. 19, provides as follows:—"Where two or more houses belonging to different owners are connected with a public sewer by a single private drain, application may be made under section 41 of the Public Health Act, 1875 (relating to nuisances in drains), and the Local Authority may recover any expenses incurred by them in executing any works under the powers conferred upon them by that section from the owners of the houses in such shares and proportions as shall be settled by their surveyor or (in case of dispute) by a court of summary jurisdiction."

"For the purpose of this section the expression 'drain' includes a drain used for the drainage of more than one building."

All these definitions have required further definition, and around them a mass of case law has accumulated, which still presents great difficulty, not only to the student, but to all sanitary officers throughout the kingdom.

The importance of these definitions will be seen from the various clauses relating to drains and sewers. Thus by sec. 13, "All existing and future sewers (with three exceptions) vest in the Local Authority," who thus become responsible for any nuisance which may arise therefrom. But a sewer may spring into being by the junction of two private drains without either the knowledge or consent of the Authority. In order to obviate some of the difficulties a system is now permissible of draining a number of houses by "Combined Operation."

The obligations with respect to sewers which rest upon the L.A. are that, in addition to being responsible for all defects and repairs, and to being the *de facto* owners of all sewers, they are liable for the quality of the sewage which they discharge. The sewage must be purified before it is sent into any stream, and the effluent from every sewage farm is liable to severe examination. In practice the action is usually taken by the County Council, or by some aggrieved riparian owner, and is laid in the County Court. If the case is made out to the satisfaction of the Court an order is made for the abatement of the nuisance caused, and this order is usually suspended for six or twelve months to give the L.A. time to execute the work necessary for abatement. This subject will receive further consideration under the head of Rivers' Pollution.

The L.A. has power to raise money for sewerage and for sewage farms and works after due enquiry by the L.G.B.; the system of sewers must be properly constructed, ventilated, cleansed, and covered, and must not be likely to become a nuisance in any way.

Private owners have also certain duties and privileges; they are entitled to drain their properties into the public sewer after notice to the L.A. and on compliance with the regulations; this must be done at the owner's cost, but by sec. 18 of the P.H.A.A., 1890, he may require the L.A. to execute the work on paying the estimated cost in advance.

On the other hand, if there be a sewer available within 100 feet of the site, and there is no sufficient drain, the L.A. may compel the owner or occupier to construct a covered drain to the sewer in accordance with their requirements.

The extent of the word "site" has been the subject of much

argument in the courts, some holding that it applies only to the ground on which the building to be drained stands, others that it includes the curtilage also; it is probable that the former view is correct, as the latter would inflict impossible duties upon the owners of mansions enclosed in parks and other houses with extensive grounds.

It only remains to add that it is not permissible to build over sewers without the written consent of the Urban Authority; that where the authority decide to change their system of sewage they have power to adapt existing drains to the new system and to close the old sewers, and that all newly erected houses and rebuilt houses in urban districts must be drained to the satisfaction of the Local Authority.

Privies, Water-closets, etc., are the subjects of clauses 35-41, and the duties of a sanitary inspector with regard to them are among the most important which he has to perform; indeed it is in sec. 36 that the inspector of nuisances is first mentioned in the Act.

It is required by the Act that every house, whether old, rebuilt, or newly-built, must be provided with a *sufficient* water-closet, earth-closet, or a privy, and an ashpit furnished with proper doors and coverings.

An ashpit includes "any ash-tub or other receptacle for the deposit of ashes, fæcal matter, or refuse" under sec. 11 of the P.H.A.A., 1890.

"Proper doors and coverings" apply to all the conveniences mentioned in the clause, and not merely to an ashpit.

"Sufficient" means sufficient in the opinion of the L.A. It has been decided, however, that a L.A. cannot pass a general resolution as to the conversion of privies into any other form of closet, but must consider each case on its merits.

The notice must use the wording of the section, and state that the premises have neither "water-closet, earth-closet, nor privy" sufficient in the opinion of the L.A. Failing the use of all three terms the notice has been thought to be bad; and further, a notice in which a particular form of water-closet has been ordered to be put in is bad, as depriving the defendant of the right to put in any "sufficient" water-closet which he might select.

In many private Acts these questions were solved by the L.A. acquiring powers to convert privies into water-closets, and, in suitable cases, to pay a portion of the cost of conversion to the owners whose properties were affected.

Also, under the P.H.A.A., 1907, Part III., section 39, the powers of local authorities as to the substitution of water-closets for privies are greatly strengthened. The Act, in whole or in part, may, with the approval of the L.G.B., be adopted in urban districts and in any contributory place within a rural district.

Sec. 38 deals with the provision of proper sanitary conveniences in factories and workshops, but has now been entirely superseded by more recent legislation. Sec. 22 of the P.H.A.A., which is adoptive in urban districts, repeals sec. 38, where it is in force, and requires the provision of proper sanitary conveniences for both sexes, the term including urinals, water-closets, earth-closets, privies, ashpits, and any similar conveniences (sec. 11, sub-sec. 3); but the report as to "sufficiency" is to be made by the surveyor for the consideration of the L.A., who can decide finally, subject to appeal as above.

And for all other places where the above clause is not in force the law is now governed by sec. 9 of the Factory Act, 1901, the terms of which are similar, but which is put in motion by an inspector of factories, acting, if he thinks fit, in conjunction with a medical officer of health, inspector of nuisances, or other officer of the District Council (sec. 5). And further, he is to give notice of any defect to the council (through their clerk), and if they fail to take action the factory inspector may do so at the expense of the council.

Any urban authority may provide public sanitary conveniences, and in this connection it is well to note that many authorities have acquired powers to close urinals abutting on the street where they are a nuisance or offensive to public decency. At the same time, under sec. 20 of the P.H.A.A. they have power to prohibit the erection of any new convenience opening on the street.

Secs. 40 and 41 impose upon the L.A. the duty of seeing that all drains, water-closets, earth-closets, privies, ashpits, and cesspools are constructed and kept so as not to be a nuisance or injurious to health, and describe in detail the method in which the duty is to be carried out.

As sec. 41 is of such vital importance to the inspector, it is here appended in full.

"On the written application of any person to a local authority, stating that any drain, water-closet, earth-closet, privy, ashpit or cesspool on or belonging to any premises within their district is a nuisance or *injurious to health* (but not otherwise), the local authority, may, by writing, empower their surveyor or inspector of nuisances, after twenty-four hours' written notice to the occupier of such premises, or in case of emergency without notice, to enter such premises, with or without assistants, and cause the

ground to be opened, and examine such drain, water-closet, earth-closet, privy, ashpit, or cesspool. If the drain, water-closet, earth-closet, privy, ashpit, or cesspool on examination is found to be in proper condition, he shall cause the ground to be closed, and any damage done to be made good as soon as can be, and the expenses of the works shall be defrayed by the local authority. If the drain, water-closet, earth-closet, privy, ashpit, or cesspool on examination appear to be in bad condition, or to require alteration or amendment, the local authority shall forthwith cause notice in writing to be given to the owner or occupier of the premises requiring him forthwith or within a reasonable time therein specified to do the necessary works; and if such notice is not complied with, the person to whom it is given shall be liable to a penalty not exceeding ten shillings for every day during which he continues to make default, and the local authority may, if they think fit, execute such works, and may recover in a summary manner from the owner the expenses incurred by them in so doing, or may by order declare the same to be private improvement expenses."

Several points in this clause require some elucidation. It will be observed that either nuisance *or* injury to health is sufficient, and that it is not necessary to prove both; that notice must be given in writing to the officer to inspect, presumably by the clerk to the Council, which should also be entered in the minutes; that, after that, twenty-four hours' written notice is to be given to the occupier before entry, presumably signed by the clerk, surveyor, inspector of nuisances, or medical officer; that where this notice is waived for emergency the Council should pass a special resolution to that effect; and that if there is no nuisance the cost falls on the Local Authority.

Where there is a nuisance, notice shall be served by the L.A., presumably after considering the written report of the inspection and signed either by the clerk, surveyor, or inspector (sec. 266). And as the medical officer possesses all the powers of the inspector of nuisances (sec. 191) his signature also is authentication enough.

The details of the procedure subsequent to the service of the notice, and the terms and authentication of notices generally, will be fully considered later on.

The meaning of private improvement expenses is set out in sec. 213, and will be dealt with under questions of procedure.

The P.H.A.A., 1890, contains other provisions on the subject of sewers and drains and of privies which can be conveniently recited here. Secs. 16 and 17 deal with matters not to be thrown into sewers, and were enacted to meet decided cases.

Under sec. 21 power is given to deal with the fouling of joint sanitary conveniences in such a way that all those using them are jointly and severally liable. This proves very useful in yards with sanitary conveniences used in common.

By sec. 24, rooms situated over privies, cesspools, middens, or ashpits are no longer to be occupied. It is presumed that the extended definition of an ashpit does not apply here.

Scavenging and Cleansing form the subjects of secs. 42-50 inclusive.

The L.A. have power (which they usually exercise) to undertake themselves, or by a contractor, the removal of house refuse and the cleansing of privies, etc.; and this duty is generally supervised by the inspector of nuisances and his subordinates, although in a good many cases the supervision is more appropriately assigned to the surveyor's department.

In districts where the L.A. undertake the work, the occupier of any house may, by written notice (presumably addressed to the clerk to the council and not to a subordinate officer), require removal or cleansing within seven days under a penalty not exceeding five shillings a day.

The definition of house refuse has given rise to litigation and does not extend to refuse from factories, things improperly placed in dustbins or trade refuse of any kind.

Where the L.A. do not undertake this duty they have power to make bye-laws imposing the duty on the occupier at certain intervals, and further powers in this direction are conferred on a L.A. who undertake the work, by contract or otherwise, by P.H.A.A., 1890, sec. 26.

The following sections empower the authority to take action in certain special cases:—

Sec. 46.—The duty to compel the cleansing and whitewashing of premises certified to the L.A. by the M.O.H., or by any two medical practitioners, as a danger to health. These powers are much enlarged under the Factory Act, the Infectious Diseases Prevention Act, etc. (*infra*).

Sec. 47.—(1) The keeping of swine in dwelling-houses or so as to be a nuisance.

(2) Stagnant water lying in any cellar or dwelling-house for twenty-four hours after notice.

(3) Percolation from any water-closet, privy, or cesspool.

In these three cases notice is to be served upon the occupier, and the penalty is not more than forty shillings and five shillings per day. The L.A. may themselves abate the nuisance and recover the cost summarily. No proof of nuisance is needed; the acts are unlawful in themselves.

Sec. 48.—Offensive ditches forming or lying near to the boundary of an adjoining district may constitute a nuisance, and either

authority may summon the other before a court of summary jurisdiction to obtain an order for the necessary works and for an apportionment of the costs between the two authorities.

Sec. 49.—Accumulations of manure, dung, soil, or filth, or other offensive or noxious matter in urban districts may be the subject of a notice, signed by the inspector, requiring its removal within twenty-four hours; in default the same may be removed and sold by the L.A., and any costs not reimbursed by the sale may be recovered from the defaulter.

Sections 51 to 70 deal with the question of water supply. The powers conferred upon L.A. to provide water, to construct waterworks, or to contract for a water supply, the restrictions imposed upon those powers, the method of procedure, the right to levy rates and similar matters do not much concern sanitary officers.

In sec. 62 the question of houses "without a proper supply of water" is dealt with, and in such cases it is the duty of the L.A. to give the owner notice in writing to provide a proper supply if there is a main within such distance that water can be supplied at the ordinary cost within the district, or, failing this, "at a cost not exceeding twopence per week, or at such other cost as the Local Government Board may, on the application of the local authority, determine under all the circumstances of the case to be reasonable."

In default the L.A. may enter and put on water, or direct the water authority or company to do so. In practice this is often found to be the most convenient way to work.

It must be noted that the L.A. require the certificate of the surveyor in this case; that the words "proper supply" have been held to include quality as well as quantity; that the cost governing the exercise of compulsion is not the cost of putting in the water, but the regular water-rate; if the owner consider the cost of putting in the water too great he has an appeal to the L.G.B. under sec. 268 of this Act.

The notice under this section must be signed by the clerk on behalf of the L.A. and not by any other officer.

In conjunction with these clauses of the Act attention must be called to the Public Health (Water) Act, 1878.

This Act was passed to compel Rural Sanitary Authorities to attend to the supply of water. Under its provisions the authority must see that every dwelling-house within their district has, within a reasonable distance, an available supply of wholesome water for consumption and domestic use.

Where such is not the case, as shown by the certificate of the M.O.H. or inspector, and the authority find that a supply can be provided at a cost of not more than 2d. per week, or, with the approval of the L.G.B., 3d., the L.A. may apply to the L.G.B. to compel the owner to provide it, and in default to order the L.A. to provide it themselves and recover the cost.

The owner may object on various grounds—*e.g.*, that the supply is not required, that the time given him is insufficient, or that it is the duty of the L.A. to provide the water, etc.

Where the objections rest upon the details of the order the case is decided by a court of summary jurisdiction, but where it is alleged that the duty should fall on the L.A. the appeal is to the L.G.B. ; in either case the method of appeal is by written memorial.

In the case of houses newly erected or rebuilt in rural districts, under this Act it is imperative on the owner to provide a water supply, and the houses cannot be occupied without a certificate of the M.O.H. or inspector that such is provided. If the certificate is refused there is an appeal to a court of summary jurisdiction and thence to Quarter Sessions.

The L.A. are under obligation to make a periodical examination of the water supply through their officers, and powers of entry for that purpose are conferred upon the L.A. or any of their officers as in secs. 102 and 103 of the Act of 1875.

The powers conferred by this Act are confined to rural areas, but an urban authority can acquire them on application to the L.G.B., if the latter so decide.

It is not necessary to enter into the details of secs. 63-67 of the P.H.A., 1875, or of the clauses of the Waterworks Act, 1847, which are incorporated with them, and passing notice only is needed of sec. 68, in which it is forbidden to pollute streams by gas washings, as this will receive further consideration under the head of Rivers' Pollution.

Sec. 70 is of considerable importance, and is appended in full :—

" On the representation of any person to any local authority that within their district the water in any well, tank, or cistern, public or private, or supplied from any public pump, and used or likely to be used by man for drinking or domestic purposes, or for manufacturing drinks for the use of man, is so polluted as to be injurious to health, such authority may apply to a court of summary jurisdiction for an order to remedy the same ; and thereupon such court shall summon the owner or occupier of the premises to which the well, tank, or cistern belongs, if it be private ; and, in the case of a public well, tank, cistern, or pump, any person alleged in the

application to be interested in the same ; and may either dismiss the application or may make an order directing the well, tank, cistern, or pump to be permanently or temporarily closed, or the water to be used for certain purposes only, or such other order as may appear to them to be requisite to prevent injury to the health of persons drinking the water.

"The court may, if they see fit, cause the water complained of to be analysed at the cost of the local authority applying to them under this section.

"If the person on whom an order under this section is made fails to comply with the same, the court may, on the application of the local authority, authorise them to do whatever may be necessary in the execution of the order, and any expenses incurred by them may be recovered in a summary manner from the person on whom the order is made.

"Expenses incurred by any rural authority in the execution of this section, and not recovered by them as aforesaid, shall be special expenses."

Under this section it is open to any person to represent to the L.A. that any water supply, whether public or private, used or likely to be used for drinking, or for manufacturing drinks, is so polluted as to be injurious to health.

Successful resistance has been offered to action under this clause on the ground that it is necessary to show that some individual's health has been injured, and that prospective or speculative injury is insufficient evidence of pollution. To meet this difficulty the corresponding provision in the London Act (sec. 54) enacts as follows :—"Polluted or likely to be polluted so as to be injurious or dangerous to health."

Secs. 71-75 deal with **cellar dwellings,** and set forth the conditions governing their occupation as follows :—

SEC. 71.—"It shall not be lawful to let or occupy, or suffer to be occupied separately as a dwelling, any cellar (including, for the purposes of this Act, in that expression, any vault or underground room) built or rebuilt after the passing of this Act, or which is not lawfully so let or occupied at the time of the passing of this Act."

SEC. 72.—"It shall not be lawful to let or occupy or suffer to be occupied separately as a dwelling, any cellar whatsoever, unless the following requisitions are complied with (that is to say) :—

"Unless the cellar is in every part thereof at least seven feet in height measured from the floor to the ceiling thereof, and is at least three feet of its height above the surface of the street or the ground adjoining or nearest to the same ; and

"Unless there is outside of and adjoining the cellar and extending along the entire frontage thereof, and upwards from six inches below the level of the floor thereof up to the surface of the said street or ground, an open area of at least two feet and six inches wide in every part ; and

"Unless the cellar is effectually drained by means of a drain, the

uppermost part of which is one foot at least below the level of the floor thereof; and

"Unless there is appurtenant to the cellar the use of a water-closet, earth-closet, or privy, and an ashpit, furnished with proper doors and coverings, according to the provisions of this Act; and

"Unless the cellar has a fireplace, with a proper chimney or flue, and an external window of at least nine superficial feet in area clear of the sash frame, and made to open in a manner approved by the surveyor (except in the case of an inner or back cellar, let or occupied along with a front cellar as part of the same letting or occupation, in which case the external window may be of any dimensions, not being less than four superficial feet in area clear of the sash frame).

"Provided that in any area adjoining a cellar there may be steps necessary for access to such cellar, if the same be so placed as not to be over, across, or opposite to the said external window, and so as to allow between every part of such steps and the external wall of such cellar a clear space of six inches at the least, and that over or across any such area there may be steps necessary for access to any building above the cellar to which such area adjoins, if the same be so placed as not to be over, across, or opposite to any such external window."

Sec. 73 provides for a penalty in case of offence; sec. 74 defines the term cellar dwelling as any cellar in which any person passes the night; while sec. 75 gives L.A. power to close cellars in case of two convictions.

The Public Health (London) Act, 1891, contains even more stringent conditions as regards occupation of such places, and the Housing and Town Planning, etc., Act, 1909, sec. 17 (7) provides that "a room habitually used as a sleeping-place, the surface of the floor of which is more than three feet below the surface of the part of the street adjoining or nearest to the room, shall, for the purposes of this section, be deemed to be a dwelling-house so dangerous or injurious to health as to be unfit for human habitation," providing (*a*) the room is not on an average at least 7 feet in height from floor to ceiling, or (*b*) it does not comply with such regulations as the L.A., with the consent of the L.G.B., may prescribe as to ventilation, lighting, and protection against dampness, effluvia, or exhalation.

Common Lodging-houses form an important part of the inspectorial work, and are regulated by secs. 76-89. In many places they are, and have been for many years, under the control of the police, but there is a growing tendency to place them under the supervision of the sanitary department, to which they more properly belong.

What is a "Common Lodging-house"? In the absence of any

definition in the Public Health Act, 1875, the following definition in the Towns Improvement Clauses Act, 1847, sec. 116, may be quoted :—

"Every house shall be deemed a public lodging-house within the meaning of the Act in which persons are harboured or lodged for a single night, or for less than a week at one time, or any part of which is let for less than a week."

In the Irish Public Health Act, 1878, the definition is :—

"A house in which, or any part of which, persons are harboured or lodged for hire for a single night or less than a week."

It does not rest with the inspector, however, to determine in doubtful cases whether a house is or is not legally a common lodging-house. In such a case, as in all cases of legal difficulty, the legal adviser of the L.A. must decide the point.

The chief provisions regulating common lodging-houses are as follows :—They must be registered by the L.A., and may not be used for this purpose until registered ; they are to be inspected before registration by an officer of the L.A. (not necessarily the M.O.H. or the inspector, but in many cases an officer appointed as inspector of lodging-houses), and notice of the registration must be affixed to the house.

By sec. 80 the L.A. have power to make bye-laws for common lodging-houses, and their powers are set out in the section. The L.G.B. have issued a code of model bye-laws on this subject and prefixed to them a memorandum which is of such value and importance to the inspector that it is desirable to quote it in full, as follows :—

"The rules which should guide the inspecting officer in his examination of the premises may be thus briefly indicated :—The house should (1) possess the conditions of wholesomeness needed for dwelling-houses in general ; and (2) it should further have arrangements fitting it for its special purpose of receiving a given number of lodgers.

"1. The house should be dry in its foundations, and have proper drainage guttering and spouting, with properly laid and substantial paving to any area or yard abutting on it. Its drains should have their connections properly made, and they should be trapped where necessary, and adequately ventilated. Except the soil-pipe from a properly trapped water-closet, there should be no direct communication of the drains with the interior of the house. All waste pipes from sinks, basins, and cisterns should discharge into the open air over gullies outside the house. The soil-pipe should always be efficiently ventilated. The closets or privies and the refuse receptacles of the house should be in proper situations, of proper construction, and adapted to any scavenging arrangements that may be in

force in the district. The house should have a water supply of good quality, and if the water be stored in cisterns they should be conveniently placed and of proper construction to prevent any fouling of water. The walls, roof, and floors of the house should be in good repair. Inside walls should not be papered. The rooms and staircases should possess the means of complete ventilation; windows being of adequate size, able to be opened to their full extent, or, if sash windows, both at top and bottom. Any room proposed for registration that has not a chimney should be furnished with a special ventilating opening or shaft, but a room not having a window to the outer air, even if it have special means of ventilation, can seldom be proper for registration.

"2. The numbers for which the house and each sleeping room may be registered will depend partly upon the dimensions of the rooms and their facilities for ventilation, and partly upon the amount of accommodation of other kinds. In rooms of ordinary construction to be used for sleeping, where there are the usual means of ventilation by windows and chimneys, about 300 cubic feet will be a proper standard of space to secure to each person; but in many rooms it will be right to appoint a larger space, and this can only be determined on inspection of the particular room. The house should possess kitchen and dayroom accommodation apart from its bedrooms, and the sufficiency of this will have to be attended to. Rooms that are partially underground may not be improper for dayrooms, but should not be registered for use as bedrooms. The amount of water supply, closet or privy accommodation, and the provision of refuse receptacles should be proportionate to the numbers for which the house is to be registered. If the water is not supplied from works with constant service, a quantity should be secured for daily use on a scale, per registered inmate, of not less than 10 gallons a day where there are water-closets, or 5 gallons a day where there are dry closets. *For every twenty registered lodgers a separate closet or privy should be required.* The washing accommodation should, wherever practicable, be in a special place and not be in the bedrooms; and the basins for personal washing should be fixed and have water-traps and discharge pipes connected with them."

With reference to the needful closet accommodation, if a lodging-house is occupied by both sexes, there must, of course, be a separate provision for each sex, and this may necessitate a larger allowance, in the gross, than one closet for every twenty persons.

The question of escape in case of fire must also be taken into account in determining the fitness of a house for registration, and, unless ample exit from upper floors is available by means of internal staircases, the provision of proper outside exits should be insisted upon.

The L.A. are empowered to require the provision of a proper water supply (sec. 81); the lime-washing of walls and ceilings twice a year (April and October) (sec. 82); the notification by the keepers of a common lodging-house of any vagrant who resorted to such house during the preceding day or night (sec. 83); the notification to the M.O.H. of the L.A. and to the poor

law relieving officer of any cases of infectious disease (sec. 84); and the free access of the inspector to the lodging-house at all times when required by him (sec. 85).

Three convictions for offences under this Act shall render the keeper liable to be debarred from keeping such a house for a period not exceeding five years from conviction (sec. 88).

Local authorities are now empowered to provide common lodging-houses of their own under the provisions of Part III. of the Housing of the Working Classes Act, 1890. Those who are curious as to the cost and working of such institutions will do well to visit and inspect the Municipal Lodging-house at Southampton.

Sec. 90 gives power to make bye-laws for **houses let in lodgings,** which will be further considered under the heading of Bye-laws.

In sec. 91 is contained the chief provision of the whole Act, for in it we meet with conditions declared to be **nuisances** under this Act.

Nuisances may be divided into two main classes :—

Nuisances at Common Law—*i.e.*, some act which unlawfully or unwarrantably injures or prejudices the rights of another person.

Such nuisance may be public, private, or mixed, and may consist of cock-crowing, bellringing and the like, and the remedy lies in the hands of the aggrieved parties, who may proceed by indictment, presentment, information or injunction; or, in the case of a private nuisance, by an action for damages. This class of nuisance, however, does not concern us here.

Statutory nuisances are those expressly so declared by Act of Parliament, and here the cases arising under this Act (P.H.A., 1875) and the Acts construed therewith are considered.

The nuisances enumerated in sec. 91 are as follows :—

"For the purpose of this Act—

"1. Any premises in such a state as to be a nuisance or injurious to health;

"2. Any pool, ditch, gutter, watercourse, privy, urinal, cesspool, drain, or ashpit, so foul, or in such a state as to be either a nuisance or injurious to health;

"3. Any animal so kept as to be either a nuisance or injurious to health;

"4. Any accumulation or deposit which is a nuisance or injurious to health;

"5. Any house or part of a house so overcrowded as to be dangerous or injurious to the health of the inmates, whether or not members of the same family;

"6. Any factory, workshop, or workplace, not kept in a cleanly state, or not ventilated in such a manner as to render harmless as far as practi-

cable any gases, vapours, dust, or other impurities generated in the course of the work carried on therein that are a nuisance or injurious to health, or so overcrowded while work is carried on as to be dangerous or injurious to the health of those employed therein ;

"7. Any fireplace or furnace which does not as far as practicable consume the smoke arising from the combustible used therein, and which is used for working engines by steam, or in any mill, factory, dyehouse, brewery, bakehouse, or gaswork, or in any manufacturing or trade process whatsoever ; and

"Any chimney (not being the chimney of a private dwelling-house) sending forth black smoke in such quantity as to be a nuisance, shall be deemed to be nuisances liable to be dealt with summarily, in manner provided by this Act."

The first sub-section is perhaps the most comprehensive, and under it will fall most of the ordinary duties of the sanitary inspector ; the word premises includes "messuages, buildings, lands, easements, and hereditaments of any tenure" (sec. 4).

It might be supposed that the first sub-section was so wide as to cover every possible case of nuisance, but the student must be warned that this is not quite so. If it were so, the enumeration of the several kinds of nuisance under the subsequent heads would be unnecessary.

Nuisances in drains (sub-sec. 2) involves a reference to the provisions of the P.H.A.A., 1890, secs. 16 and 17, but, as this Act provided no definition of drains or sewers, the application of the case is doubtful.

Sub-section 3 refers to all animals, but, in the case of swine, there is an alternative remedy in sec. 47, or in any bye-laws properly made and approved under sec. 44 for the keeping of animals.

In sub-section 5 there may not infrequently arise cases in which the tenant is at fault quite as much as the landlord. It is, however, obvious that the remedy is in the hands of the landlord, upon whom notice of the nuisance should be served. This overcrowding prohibition applies to night-shelters and houses equally.

The difficulties of administering the provisions of sub-section 7, relating to **smoke nuisances,** are well known. As a rule, the average Health Committee is unwilling to take action as appearing to constitute a hindrance to trade, and, further, the decisions of the courts as to the liability of the owner of a furnace for the bad and negligent stoking of his employees are decidedly conflicting. In several such cases it has been held, however, that, if proper smoke-preventing appliances have been provided, the servant of the owner of the works who has neglected to make proper use of such appliances is the person to be proceeded against

for a resulting smoke nuisance, providing it can be shown that the person in question is competent, and that the nuisance resulted from his neglect.

As it can clearly be shown that it is to the economic advantage of manufacturers to adopt every precaution to prevent smoke nuisances, and do their utmost to insure that smoke-preventing appliances are properly used, authorities should not hesitate to exercise their powers in cases of default. At the same time, discretion must be exercised in determining whether or not proceedings should be taken in court, and the evidence as to nuisance must be so conclusive as to render conviction practically certain. It is the inspector's duty to supply this evidence, which he can only do by carefully observing and recording the facts.

The first point to be determined is what shall be deemed to constitute a smoke nuisance. Clearly, no matter how perfect the smoke-preventing appliances provided may be, and notwithstanding the fact that every care is taken to see that they are properly used, black smoke must occasionally, and for short periods, be discharged from factory chimneys; for example, on first lighting the furnace and subsequently from any accidental cause. As regards the practice of authorities in determining the degree of offence which would warrant proceedings, the permissible period for the issue of black smoke varies very much. The London County Council allow five minutes from the lighting of the furnace and one minute afterwards, and this seems to be reasonable. In Sheffield, on the other hand, the period allowed varies according to the number of boilers, from two minutes in the case of one boiler to six in the case of four or more, the observation to extend for one hour at a time.

It rests with the inspector to determine what is black smoke, and his testimony in this respect must be unshakeable. Photography may be employed in support of his evidence, but, after all, carefully kept observation records as to the volume of smoke and degree of blackness are the facts which will carry most weight.

In this case, as in the case of other nuisances, much may be accomplished by a tactful inspector without taking extreme measures, and it is only when he is satisfied that there is deliberate neglect, or when the factory owner refuses to provide the needful means of prevention that he need ask his L.A. to sanction proceedings. It may here be mentioned that the L.A., in their notice to remedy such a nuisance, need not specify any work

which it may be necessary to carry out, the onus is on the owner of the factory to adopt all reasonable measures of prevention.

In colliery districts, nuisance frequently arises from burning pit mounds, but it has been decided that this does not constitute a nuisance from which relief can be obtained.

In addition to the nuisances under this section enumerated above, there are certain other cases declared by statute to be nuisances within the meaning of the Act, as follows:—

1. Coal Mines Regulation Act, 1887, sec. 37. Unfenced shafts or side entrances to disused mines within 50 yards of any highway, road, footway, or place of public resort, or in open or enclosed land.

2. Metalliferous Mines Regulation Act, 1872, sec. 13. An almost similar provision, but subject to a notice by an inspector of mines that it is dangerous.

3. Quarry Fencing Act, 1887, sec. 3. A similar provision applying to all quarries, whether in use or disused, and carrying a definition of the word "quarry."

4. Housing of the Working Classes Act, 1885, sec. 9.

The only remains of this Act unrepealed are sections 7, and parts of 8, 9, and 10.

Sec. 9.—A tent, van, or similar structure used for human habitation, which is in such a state as to be a nuisance or injurious to health, or which is so overcrowded as to be injurious to the health of the inmates, whether or not members of the same family, shall be deemed to be a nuisance within the meaning of sec. 91 of the Public Health Act, 1875.

This section also confers a power of entry to any person duly authorised between the hours of 6 a.m. and 9 p.m., on producing his authority to enter.

The various steps to be taken by the Local Authority and by their officers for the detection and abatement of nuisances form one of the most important portions of the Act, and occupy secs. 92-111.

By sec. 92 it is the duty of the L.A. to cause to be made periodical inspections of their district to discover nuisances requiring abatement, and to enforce the provisions of this Act; and also to enforce the provisions of any Act in force in the district affecting smoke nuisances—*e.g.*, any local Acts on the subject. Further, it is within the rights of any person aggrieved, or any two inhabitant householders, or the relieving officer or the police to give information of a nuisance (presumably in writing to the clerk to the authority)—(sec. 93).

The L.A. must consider the complaint and, if satisfied of the existence of the nuisance, shall serve a notice on the person by whose act or default the nuisance arises or continues, or failing him upon the owner or occupier, requiring him to abate the nuisance and to do such work as may be necessary for the purpose.

Provided—1. That where the nuisance arises from the want or defective condition of any structural convenience, or where there is no occupier, notice is served on the owner.

2. Where the owner and occupier are not at fault and the real person in default cannot be found the L.A. may abate the nuisance themselves without further order.

It is to be observed that the notice given under this section is a formal notice given by the order of the L.A. usually acting through a committee whose actions are confirmed by the council. There is, however, no bar to the issue in every case of a warning or preliminary notice, which, though it has no statutory value, will probably effect the abatement of a large number of nuisances.

The L.A. cannot pass a general resolution directing a notice to be served in every case of a particular class of nuisance, but must consider and decide every case on its merits. The question of the right person to be served with the notice is, of course, an important one, and herein the definition of "owner" becomes material. "Owner" means the person for the time being receiving the rack-rent of the lands or premises in connection with which the word is used, whether, on his own account, or as agent or trustee for any other person, or who would so receive the same if such lands or premises were let at a rack-rent (sec. 4). "Rack-rent is not less than two-thirds of the full annual value of the property."

This definition of "owner" holds good in most cases, except under the Housing of the Working Classes Acts, where a special definition is given (Act of 1890, sec. 29, amended by sec. 49 (2) of the Act of 1909), which will receive notice in due course.

It is naturally an essential in the service of a notice that the person upon whom the notice is served should be able to comply with it, and the notice in itself will not confer a power of entry upon an owner which he does not otherwise possess. The conflict of cases in this question is very great.

The next step in case of non-compliance with the notice is to lay an information before a justice to issue a summons on the defaulter to appear before a court of summary jurisdiction. The details of this procedure will be considered later under the special clauses of Part VII. of the Public Health Act, 1875.

The **right of entry** is provided in sec. 102, and is so important that it is here set out in detail :—

"The local authority, or any of their officers, shall be admitted into any premises for the purpose of examining as to the existence of any nuisance thereon, or of enforcing the provisions of any Act in force within the district requiring fireplaces and furnaces to consume their own smoke, at any time between the hours of nine in the forenoon and six in the afternoon, or in the case of a nuisance arising in respect of any business, then at any hour when such business is in progress or is usually carried on.

"Where, under this Act, a nuisance has been ascertained to exist, or an order of abatement or prohibition has been made, the local authority or any of their officers shall be admitted from time to time into the premises between the hours aforesaid until the nuisance is abated, or the works ordered to be done are completed, as the case may be.

"Where an order of abatement or prohibition has not been complied with, or has been infringed, the local authority, or any of their officers, shall be admitted from time to time at all reasonable hours, or at all hours during which business is in progress or is usually carried on, into the premises where the nuisance exists, in order to abate the same.

"If admission to premises for any of the purposes of this section is refused, any justice, on complaint thereof on oath by any officer of the local authority (made after reasonable notice in writing of the intention to make the same has been given to the person having custody of the premises), may, by order under his hand, require the person having custody of the premises to admit the local authority, or their officer, into the premises during the hours aforesaid ; and if no person having custody of the premises can be found, the justice shall, on oath made before him of that fact, by order under his hand authorise the local authority or any of their officers to enter such premises during the hours aforesaid.

"Any order made by a justice for admission of the local authority or any of their officers on premises shall continue in force until the nuisance has been abated, or the work for which the entry was necessary has been done."

For any obstruction to these rights, the penalty is fixed by the succeeding clause at not more than £5.

In addition to the power of entry conferred by this section (102), the following powers are conferred upon the L.A. and its officers under various sections of the P.H.A. and other Acts relating to Public Health in connection therewith :—

1. P.H.A., sec. 85.—To any officer of the L.A. to inspect common lodging-houses at any hour of the day or night.

2. P.H.A., sec. 116.—To the M.O.H. or inspector, at any reasonable hour, to inspect meat, etc., intended for the food of man.

3. To any officer to enforce orders for epidemic diseases made by the L.G.B. under sec. 134. No hour stated.

4. Towns Improvement Clauses Act, 1847, sec. 131.—To the

M.O.H. or inspector, or other specially appointed officer, to inspect any place used for the sale of butchers' meat or any slaughter-house, etc., at all reasonable times.

5. Infectious Diseases (Prevention) Act, 1890, sec. 17.—To carry out the provisions of sec. 5 of the Act under written authority between 10 a.m. and 6 p.m.

6. Public Health (Water) Act, 1878, sec. 7.—In rural districts to inspect water supplies. The same powers as in sec. 102 of the P.H.A.

7. Public Health Acts Amendment Act, 1890, sec. 17.—To detect any contravention of sec. 17, sub-sec. (1), relating to chemical refuse, etc., thrown into sewers; no limitation of time fixed.

8. Housing of the Working Classes Act, 1885, sec. 9.—To any authorised officer to enter and inspect tents, sheds, and vans for nuisances and infectious diseases.

9. Canal Boats Act, 1877, sec. 5.—To any authorised inspector to enter in case of infectious disease by day—*i.e.*, between 9 a.m. and 6 p.m.

10. Contagious Diseases (Animals) Act, 1886, sec. 9.—(*N.B.*—The rest of this Act is repealed by the Contagious Diseases (Animals) Act of 1894.)—The same powers as conferred by sec. 102, *supra*, for the purpose of enforcing the regulations made by the L.A. and the central authority.

11. Factory Act, 1891, sec. 125.—Power of entry to any workshop or workplace to all officers similar to those of the Factory Inspector.

12. Housing, Town Planning, etc., Act, 1909, sec. 36.—For survey and examination.

There are also powers capable of being granted by a justice to enter under certain circumstances, but these are more in the nature of legal proceedings than of a statutory right, and are noticed as they occur.

It must, however, be noticed that these powers are enforced on application for a justice's order made under sec. 305, which applies to a number of cases in which the individual section does not give the necessary powers. The power of reviewing the notice upon which the proceedings taken under this section are based is apparently limited to the consideration of the words "sufficient cause," and the actual facts of the case cannot be discussed.

Offensive trades are defined in sec. 112 as the trade of bone boiler, blood boiler, fellmonger, soap boiler, tallow melter, tripe

boiler, or any other noxious or offensive trade, business, or manufacture.

These trades cannot be carried on without a license under a penalty not exceeding £50, and 40s. a day for every day after warning.

The definition is a wide one, and has been held to include among others the trade of cattle-slaughtering, brick-burning, rag sorting, manure making, and a variety of chemical processes and manufactures in which an organic basis is employed.

It may also be noted that the possession of a licence does not protect the manufacturer from an action for a nuisance at common law.

The next section (113) deals with all nuisances causing effluvia, whether established before or after the commencement of the Act. Complaint may be made to an urban authority by the M.O.H., two registered medical men, or ten inhabitants of the district of a nuisance arising from such manufactory, and the L.A. shall take proceedings before a justice. The court shall hear the case, and, unless it be shown that the manufacturer has used the best known method of preventing the nuisance, may impose a fine or adjourn the case for such method to be adopted. There is an appeal to Quarter Sessions.

The L.A. has power to make bye-laws governing the conduct of offensive trades, as will be seen from the list of model bye-laws; they also have power to complain of effluvia nuisances in an adjoining district if their own inhabitants complain.

It is well for the inspector to inform himself of the various processes, which fall under these clauses, which are carried on in his district, and to learn whether the methods of carrying them on are sufficiently modern as to be the best known methods of preventing nuisance.

The classical book of reference on the subject is the report of Dr. Ballard, published by the L.G.B. in their series of annual reports in the years 1877, 1878, and 1879; these are now out of print, but could probably be referred to in any good sanitary library.

As slaughter-houses have been alluded to under the heading of offensive trades, it will be convenient to consider at this point the sections (169 and 170) of the P.H.A., with which are incorporated secs. 125-130 of the Towns Improvement Clauses Act, 1847, and also the sections of the P.H.A.A. which may be adopted with regard to this matter.

An urban authority has power to license slaughter-houses and

knackers' yards, and no such place shall be used or occupied without a license, unless it was so used before the passing of the Special Act, and has continued in use ever since.

The "Special Act" means any Act passed for the improvement or regulation of towns and districts, and incorporating therein the provisions of the Towns Improvement Clauses Act (sec. 2). In this case it is the Public Health Act, 1875.

Any place being so used without a licence renders the person using the place liable to a penalty of not exceeding £5, and £5 a day afterwards. Slaughter-houses in use before the passing of the Special Act (*i.e.*, before 1875) do not need a licence, but must be registered.

The L.A. shall keep a register of both classes of slaughter-houses, and must make bye-laws for their regulation and proper keeping, to prevent cruelty therein, and for cleanliness, removal of filth, and efficient water supply, drainage, etc. Justices have power upon conviction for any offence under these clauses, or under the bye-laws made in pursuance of them, not only to inflict a penalty, but also to suspend the use of the slaughter-house for not more than two months, and in the case of a subsequent conviction may revoke the licence.

Every place so registered or licensed must have affixed to the door of the same a plate with the words "Licensed slaughter-house" or "Registered slaughter-house," as the case may be, under a penalty of not more than £5, and 10s. a day after (sec. 170).

Powers are given to urban authorities to provide public slaughter-houses and to make bye-laws for their use and management.

Further powers are given to those urban districts who have adopted the P.H.A.A., 1890, Part III., by sections 29-31, as follows:—

"29. Licences granted after the adoption of this part of this Act for the use and occupation of places as slaughter-houses shall be in force for such time or times only, not being less than twelve months, as the urban authority shall think fit to specify in such licences.

"30. (1) Upon any change of occupation of any building within an urban sanitary district registered or licensed for use and used as a slaughter-house, the person thereupon becoming the occupier or joint occupier shall give notice in writing of the change of occupation to the inspector of nuisances.

"(2) A person who fails or neglects to give such notice within one month after the change of occupation occurs shall be liable to a penalty not exceeding five pounds.

"(3) Notice of this enactment shall be endorsed on all licences granted after the adoption of this part of this Act.

"31. If the occupier of any building licensed as aforesaid to be used as a slaughter-house for the killing of animals intended as human food is convicted by a court of summary jurisdiction of selling or exposing for sale, or for having in his possession, or on his premises, the carcase of an animal, or any piece of meat or flesh diseased or unsound, or unwholesome or unfit for the use of man as food, the court may revoke the licence."

The natural object of the L.A. is, as far as possible, to get all these places under the control of the Sanitary Department, and to be able to refuse licences without the cumbersome machinery of two convictions. The first duty of the inspector is, therefore, to carefully compare the register with the existing places, and to ascertain that they are all in continuous occupation. The question of how long a slaughter-house must remain disused has not been settled in a higher court, but it may be taken that six months would be a reasonable time, or the use of the building for other purposes; it is a sufficient use if cattle are kept there for fasting before slaughter.

It must be remembered that slaughter-houses are licensed as to premises and not persons, and that change of occupancy, although requiring notice under the above section, does not involve a new licence.

The power of entry into slaughter-houses is conferred by sec. 116 at all reasonable times, and, as Sunday has been held to be not an unreasonable time, it follows equally that any time at which slaughtering is being carried on is a reasonable time. This must be so to be effective, as most killing of unfit beasts is carried on at unreasonable hours, and frequently at night.

Special attention is directed to the Model Bye-laws of the L.G.B. on this subject, which will be considered later, but it is well to call attention here to the forms of licence and of authority to build which are contained in them, and which may be amplified as circumstances may require, and also to the memorandum prefixed to them, which is here set out in full:—

"The following rules as to site and structure should influence the decision of the Urban Authority upon each application for a licence:—

"1. The premises to be erected or to be used and occupied as a slaughter-house should not be within 100 feet of any dwelling-house; and the site should be such as to admit of free ventilation by direct communication with the external air on two sides at least of the slaughter-house.

"2. Lairs for cattle in connection with the slaughter-house should not be within 100 feet of a dwelling-house.

"3. The slaughter-house should not in any part be below the surface of the adjoining ground.

"4. The approach to the slaughter-house should not be on an incline

of more than one in four, and should not be through any dwelling-house or shop.

"5. No room or loft should be constructed over the slaughter-house.

"6. The slaughter-house should be provided with an adequate tank or other proper receptacle for water, so placed that the bottom shall not be less than six feet above the level of the floor of the slaughter-house.

"7. The slaughter-house should be provided with means of thorough ventilation.

"8. The slaughter-house should be well paved with asphalt or concrete, and laid with proper slope and channel towards a gully, which should be properly trapped and covered with a grating, the bars of which should be not more than three-eighths of an inch apart.

"Provision for the effectual drainage of the slaughter-house should also be made.

"9. The surface of the walls in the interior of the slaughter-house should be covered with hard, smooth, impervious material to a sufficient height.

"10. No water-closet, privy, or cesspool should be constructed within the slaughter-house.

"There should be no direct communication between the slaughter-house and any stable, water-closet, privy, or cesspool.

"11. Every lair for cattle in connection with the slaughter-house should be properly paved, drained, and ventilated, and no habitable room should be constructed over any lair."

The four sections 116-119 are devoted to the regulations for the inspection of unsound meat, etc., and commence by conferring upon the M.O.H. or the inspector the power of entering upon premises at all reasonable times to examine any animal, carcase, meat, poultry, game, fish, flesh, fruit, vegetables, corn, bread, flour, or milk exposed for or deposited in any place for the purpose of sale, or of preparation for sale, and intended for the food of man.

If unfit or unwholesome, he may seize the same and carry it away to be dealt with by a justice.

The definition in the above section was found not to be wide enough, and has now been extended by sec. 28 (1) of the P.H.A.A., 1890, to include all articles intended for the food of man, thus adding to the above list eggs, butter, cheese, and other articles.

The question of reasonable time under this section has already been discussed, but the word place has been held to include a butcher's cart in the street passing from slaughter-house to manufactory.

It is customary, but by no means necessary, to give the owner of the goods seized the opportunity of appearing before the justice who is asked to decide upon them, but this belongs more properly to the next section. The power of seizure belongs only to the M.O.H. or inspector, and cannot be delegated to an assistant.

Two judicial actions may now take place :—

1. The justice to whom the article is taken may condemn the same and order it to be destroyed. He may, if he please, hear the owner, but this is optional on his part. If the justice declines to condemn it, the owner cannot refuse to take it back, but is entitled to any expense or loss he may have incurred by the seizure.

2. The owner may further be summoned before a court of summary jurisdiction without any reference to the individual justice who condemned the article, and, if convicted, is liable to a penalty for each article or piece of meat not exceeding £20, or to not more than three months' imprisonment.

Under the P.H.A., if there be any flaw in the seizure of the goods, the whole of the subsequent proceedings are liable to be quashed as invalid, but where the P.H.A.A., sec. 28 (2), is in force the question of seizure no longer affects the validity of the subsequent proceedings.

It will thus be noticed that considerable care must be exercised in meat seizures, especially where it is proposed to carry the case further than condemnation and destruction of the article seized. Meat may be, and often is, surrendered voluntarily by the butcher, and offered for inspection and condemnation. No action can be taken on this. Where a carcase has not been dressed, or where it has been "thrown down," the question of seizure is surrounded with risks, and it is hard to disprove the statement of the butcher that he had not intended it for the food of man; where persons have been known to slaughter in a slaughter-house held by another man, the question of the proper owner of the meat there seized has been in doubt.

Under the provisions of the Horseflesh Act, 1889, it is necessary that, where horseflesh is sold for the food of man, the shop or stall where it is sold shall be distinctly and conspicuously labelled in letters not less than 4 inches long. The M.O.H., inspector, or other officer properly authorised, may at all reasonable times examine and inspect, and where necessary seize, etc., as in the case of other meat.

Horseflesh may be defined as including the flesh of asses and mules, and may be cooked or uncooked, alone or mixed with any other substance. The sale of horseflesh in this country is comparatively rare, but it is advisable for an inspector to be able to recognise it on inspection, so as to carry out this Act efficiently

Infectious Diseases, Infectious Hospitals, Epidemic Diseases, etc.

In the Act of 1875, no less than twenty-one clauses are assigned to the important subject of the regulation and prevention of infectious and epidemic disease, and these sections have been strengthened and amended by the following Acts and sections :—

The Epidemic and other Diseases Prevention Act, 1883.
The Public Health (Ships) Act, 1885.
The Infectious Disease (Notification) Act, 1889.
The Infectious Disease (Prevention) Act, 1890.
The Public Health (Ports) Act, 1896.
The Public Health Act, 1896.
The Infectious Disease (Notification) Extension Act, 1899.
The Isolation Hospitals Acts, 1893 and 1901.
The Public Health (Prevention and Treatment of Disease) Act, 1913.
The Public Health (London) Act, 1891, secs. 55-74, inclusive.

It will, therefore, be necessary to take these Acts as a connected whole, remembering that the Preventive Act is only adoptive and not of universal application. It is true that in the duties assigned by the memo. of the L.G.B. to the inspector of nuisances there is no mention of the inspection of infected dwellings, this duty being assigned to the medical officer, but it is equally true that it is physically impossible for a M.O.H. to visit all premises notified and certain duties must, of necessity, devolve upon the inspectorial staff.

The first intimation of an outbreak of infectious disease comes by the operation of the Notification Act of 1889, which, originally adoptive, was made compulsory in England and Wales by the Extension Act of 1899. The diseases to which this Act applies are :—Smallpox, scarlet fever or scarlatina, cholera, plague, diphtheria, membranous croup, erysipelas, and the fevers known as typhus, typhoid (enteric), relapsing, continued, and puerperal, and such other diseases as may be added temporarily or permanently by the L.A., with the approval of the L.G.B., by the powers conferred on them in sec. 7.

By order of the L.G.B., all cases of tuberculosis occurring in the practices of medical practitioners and school medical inspectors became notifiable on 1st January, 1912, as well as cerebro-spinal fever and poliomyelitis on 1st September, 1912, measles and German measles (first cases in families) on 1st January, 1916, acute encephalitis lethargica and acute polio-encephalitis on 1st January, 1919, and malaria, dysentery, trench fever, acute primary pneumonia, acute influensal pneumonia on 1st March, 1919. These additions, as already stated, will undoubtedly increase the inspectorial work, and will render all the more necessary the appointment of health visitors. The practice of appointing health visitors is becoming more general since the Notification of Births (Extension) Act, 1915, and the Maternity and Child Welfare Act, 1918, came into operation, and undoubtedly these officers are the proper persons to undertake the health visiting of such cases.

The health visitor should also be entrusted with the visitation of homes from which cases of tuberculosis have been reported, in order to note the environmental conditions; advice as to the best way of utilising the accommodation available from the point of view of the patient himself and the safety of other members of the family; see that the patient is following the directions of the medical man in attendance; and, where home shelters are in use, noting whether they are habitually being used, and are kept clean and in proper order.

If the notification is in order and signed by a properly qualified medical practitioner, it is not the duty of any person to question the accuracy of the diagnosis. Where removal to a hospital follows upon notification in the case of smallpox, scarlet fever, or enteric fever, mistakes are occasionally detected, but they are much more rare than formerly. The routine practice in many towns is for the medical man to state on the notification if the case is not one for removal, and as far as possible such wish is respected. Failing this, it becomes the duty of the L.A. to visit the premises, and through the visiting inspector to acquire as much information as possible, and if necessary to remove the case. The particulars needed include number of rooms, number of inmates, water supply, milk supply, school (if any), and the general sanitary condition of the premises. Should removal be considered necessary, and the patient or friends refuse to permit it, the following section comes into operation; and as much doubt exists about its meaning it is here set out in full :—

Sec. 124.—"Where any suitable hospital or place for the reception of the sick is provided within the district of a local authority, or within a convenient distance of such district, any person who is suffering from any dangerous infectious disorder, and is without proper lodging or accommodation, or lodged in a room occupied by more than one family, or on board any ship or vessel, may, on a certificate signed by a legally qualified medical practitioner, and with the consent of the superintending body of such hospital or place, be removed, by order of any justice, to such hospital or place at the cost of the local authority; and any person so suffering, who is lodged in any common lodging-house, may, with the like consent and on a like certificate, be so removed by order of the local authority.

"An order under this section may be addressed to such constable or officer of the local authority as the justice or local authority making the same may think expedient; and any person who wilfully disobeys or obstructs the execution of such order shall be liable to a penalty not exceeding ten pounds."

The penalty for obstruction to the officer in the carrying out of the order, is a sum not exceeding £10; and in hearing a summons for obstruction it has been held that the court has no right to question the validity of the order.

The L.A. may also make regulations for the removal and detention of infected persons brought into their district by ships (sec. 125) and by sec. 12 of the Infectious Diseases (Prevention) Act, may, by a justice's order, detain all cases admitted into hospital under any circumstances for such time as may be deemed necessary.

The case being removed to hospital or having recovered, the question of disinfection now arises, and this is dealt with under several sections, beginning with sec. 120.

In this section the duty is laid upon the L.A. of causing premises to be cleansed and disinfected whenever they are satisfied, on the certificate of their M.O.H. or any other qualified practitioner, that such action is necessary to prevent or check infectious disease.

Notice to carry out the cleansing and disinfection may be given in writing to either owner or occupier, and, in default, the L.A. may enter, do the work, and recover the expenses in a summary manner. They may also do it at their own cost where it appears that, from poverty or other cause, the owner or occupier is unable to do it.

This section has been repealed in all districts in which the Infectious Diseases (Prevention) Act has been adopted, and sec. 5 of that Act has superseded it. The main effect of this section is to empower the L.A. to disinfect the house at the

owner's cost unless the owner gives notice within twenty-four hours that he will do it himself.

Other provisions for cleansing and disinfection are contained in sec. 46 and under bye-laws to be made pursuant to secs. 80 and 90.

Further, by sec. 121 the L.A. can order the destruction of infected bedding, etc., and give compensation for the same. By sec. 6 of the I.D.P. Act they may alternatively require that the bedding, etc., be handed over to them for the purpose of disinfection free of charge under a penalty of not more than £10. They have already got power by sec. 122 to provide a proper disinfecting station, and to disinfect free of charge, and also to provide ambulances, etc.

By sec. 126 the exposure of persons in public places while suffering from any "dangerous infectious disorder," either by their own act, or by the negligence of others, and also the transmission of infected rags, clothing, etc., is forbidden under a penalty not exceeding £5.

The class of cases which arise under this section includes those where a man is discovered in the street, or in a surgery, or at the out-patient department of a hospital.

The compulsory disinfection of a public conveyance (*i.e.*, one which plies openly and publicly for hire) is provided for in sec. 127. It is to be presumed that a jobmaster is at liberty to decline to remove a case of this character if he choose, even though the cost of disinfection be guaranteed him, plus compensation for any loss sustained.

The letting of lodgings for hire where there has been a case of infectious disease without previous disinfection, and the making of a false statement with regard to such letting are made the subjects of a penalty by secs. 128 and 129, and by the Infectious Diseases (Prevention) Act the latter section is extended to cover a statement made by any person ceasing to occupy such house or lodgings (sec. 7).

Sec. 130 gives power to the L.G.B. to make regulations for epidemic, endemic, or infectious diseases, and needs no comment, and the powers are further extended by the Public Health Act, 1896, and the Public Health (Ports) Act, 1896.

The provision of hospitals for the reception of the sick is an optional duty of the L.A., who may themselves provide a hospital or contract with the owners of an existing hospital for the reception of their cases.

The diseases to be admitted are not here defined, but so far

they have usually been confined to smallpox, scarlet fever, diphtheria, typhoid fever, and occasionally measles. The duty of the L.A. to provide a hospital is merely permissive, and does not in any way supersede the powers and duties of Poor Law Guardians to provide for their sick paupers.

As a result of a number of actions brought to restrain the erection of hospitals for Local Authorities, alleging a nuisance or danger to the health of the surrounding population, the L.G.B. have now issued a set of stringent rules as regards small-pox hospitals as to the distance which the site should be within a given circumference, having regard to the number of people residing within varying radii.

The L.A. cannot refuse admission to a pauper case, but it would appear that they are entitled to recover from the guardians the cost of each patient. In practice this is usually done by a contract to treat each patient for a fixed price per week. A L.A. which formed only part of the Poor Law Union, whose workhouse was situated in their district, admitted all cases belonging to their own district occurring in the workhouse, but compelled the guardians to pay for cases admitted into the workhouse and thence into the hospital from the other districts of the Union. This appears to be a reasonable contention. Persons who are not paupers may be called upon to pay the costs of treatment and maintenance, but in practice the recovery of such expenses has been found very difficult, and a grave hindrance to the carrying out of the object for which the hospital was established—viz., the isolation and suppression of infectious disease.

Sec. 133, enabling a L.A. to provide a temporary supply of medicine, is rarely put into operation, except as regards supplying anti-toxin serum.

Secs. 134 to 140 inclusive are concerned with the prevention of "epidemic, endemic, or infectious disease," and under them the L.G.B. have power, on the threatened invasion of any disease, to make regulations for the speedy interment of the dead, for house to house visitation, for the provision of hospital accommodation and medical aid, for the promotion of cleansing, ventilation, and disinfection, and for guarding against the spread of disease; and power of entry is given for the purpose of carrying out these regulations on any premises or vessel (presumably at all hours, as no limit is stated in clause 137).

The following definitions taken from the Medical Lexicon may be useful:—"Epidemic diseases are diseases prevalent

among a people or a community at a special time or produced by some special cause not generally present in the affected locality."

"Endemic diseases are those which are peculiar to a people, a country, or a neighbourhood."

Thus, smallpox, measles, and scarlet fever may be said to be epidemic; typhoid may be epidemic, and is in some towns endemic; goitre, leprosy, and yellow fever are endemic in certain places.

These powers have been further extended by the Epidemic and other Diseases Prevention Act of 1883.

An extension of the power to provide hospitals was conferred upon County Councils by the Isolation Hospitals Acts of 1893 and 1901. It is enacted that on application from any district within their area the Council may establish a hospital for the reception of patients, with proper ambulance, etc., and may there train nurses, etc.

The Council may also, without application, direct an inquiry by their own M.O.H., and act in such case as if an application had been made to them by a L.A. The further details of these Acts do not here concern us.

Having hitherto dealt with the living, the Act now makes provision for the dead, and by the sections from 141 to 143 and other subsequent enactments the following regulations are enacted:—

The L.A. may, and if required by the L.G.B. shall, provide a proper place for the reception of dead bodies before interment, called a mortuary, and shall make bye-laws to regulate the same. To this place may be removed by a Justice's order the body of any person which is in such a state as to endanger the health of the inmates of the house or room in which it lies, on a certificate from a qualified medical practitioner; and if the relatives or friends do not bury it, the duty of burial falls upon the relieving officer, who can recover his expenses from any person legally liable for the burial. The L.A. may also provide a place for conducting post-mortem examinations ordered by the Coroner, but not at a workhouse or in the same room as a mortuary. It is customary for such a place to be provided on the same premises as the mortuary, but in an absolutely distinct room or building. The Coroner may, where such a place is provided, order the body to be removed thither for the purposes of post-mortem examination, and, if he thinks fit, returned to the house afterwards, and reasonable expenses may be charged (Coroners

Act, 1887, sec. 24). This section supersedes the latter portion of sec. 143 as originally enacted. The duty of burial only falls upon the relieving officer in those cases in which the body has been removed to the mortuary by order of a Justice; in other cases, the duty falls upon the L.A., who should include proper regulations for it among their bye-laws.

These powers are further extended by the Infectious Diseases Prevention Act, 1890, as follows:—

Sec. 8 prohibits the retention of a dead body for more than forty-eight hours in cases of infectious disease, except in a mortuary, or a room not used as a dwelling-place, sleeping-place, or work-room, without the written permission of the M.O.H., or of a registered medical practitioner, and is obviously intended to apply to families living in one room, or having no separate room in which to deposit the body. Further, by the next section the bodies of persons dying from infectious disease in hospital, or any place of temporary accommodation for the sick, if a certificate is given by the M.O.H., or a registered practitioner as before, can only be removed either to a mortuary or direct to the place of burial; and where bodies remain unburied in such a place, for so long as to endanger health, a Justice's order may be obtained for their immediate interment, the duty, in default of the relatives, etc., falling, as above, on the relieving officer.

It is the common law duty of the person in whose house the dead body is lying to inter the body decently, and consequently the hospital authorities, and not the Guardians, are responsible for the dead bodies of those who die in hospital.

Finally, the use of any public conveyance other than a hearse is safe-guarded in the case of those who have died of some infectious disease, and such conveyance must be disinfected under a penalty.

The remaining provisions of the I.D.P. Act which require notice are sec. 13, which forbids the throwing of infectious rubbish into ashpits, ashtubs, etc., without previous disinfection. This is intended to cover typhoid dejecta, poultices, rags, etc., and entails a penalty. Sec. 14 requires that, where secs. 7 and 13 of this Act are in force, a notice shall be given of the provisions thereof to occupiers of houses in which there is infectious disease. It will be well, therefore, to have a small leaflet printed for circulation among suitable cases in which infectious disease has been notified.

By sec. 15 the L.A. may provide temporary shelter for people

compelled to leave their dwellings by reason of disinfection after any infectious disease.

Reference must here be made to the Public Health (Prevention and Treatment of Disease) Act, 1913, sec. 1 of which gives the L.G.B. power to make an order enabling local authorities who may be constituent authorities of joint Boards to exercise any powers of the joint Board, notwithstanding the provisions of sec. 281 of the Public Health Act, 1875.

Sec. 2 of this Act enables the L.G.B. to declare that one of the authorities to enforce regulations made by the Board under sec. 130 of the Public Health Act, 1875, regarding the treatment of persons suffering from certain infectious diseases shall be the council of a county.

Sec. 3 of this Act gives similar power to the L.G.B. as regards the treatment of tuberculosis, enabling provision for the treatment of such cases to be made by the council of any county or any sanitary authority, such to be in addition to and not in derogation of any other power.

Distribution of Poisonous Disinfectants.—In many instances it is the practice of local authorities to gratuitously distribute poisonous liquid disinfectants, and frequently ordinary bottles, such as beer bottles, are used for the purpose. By an Order of the L.G.B., dated 22nd March, 1911, the following requirements are laid down, and should be carefully observed by inspectors :—All liquid disinfectants containing poison, such as carbolic acid or carbolic substitutes, shall be sent out in bottles (*a*) rendered distinguishable by touch from ordinary bottles or medicine bottles, and (*b*) that sec. 5 of the Poisons and Pharmacy Act, 1908, be complied with—namely, that the bottles or containers shall bear, distinctly printed thereon, the words "Not to be taken."

Part IV. of the Public Health Act, 1875, is devoted to the enactments relating to Local Government provisions, among which are included highways and streets, public pleasure grounds, markets and slaughter-houses, and police regulations. Of these, the question of slaughter-houses has already been dealt with, and the rest concern the duties of the surveyor rather than the sanitary department. It will, however, be necessary to allude briefly to a few of the points raised upon these sections.

The definition of the word "street" has been the subject of much argument, and is given in sec. 4 as follows :—"Street" includes any highway and any public bridge (not being a county bridge; *i.e.*, erected before 1803), and any road, lane, footway,

square, court, alley, or passage, whether a thoroughfare or not. But this definition, unfortunately, does not apply to all the sections in the Act in which the word is used, and some of these have to be considered separately and different meanings assigned to the word.

"House" includes schools, also factories and other buildings in which persons are employed.

"Building" has a wider meaning than the term house, and is not defined. Further than this, the sections dealing with these subjects do not concern the inspector, and may here be dismissed, together with the amending sections of the P.H.A.A., the incorporated clauses of the Towns Improvement Clauses Act, 1847, and the Model Bye-laws on these subjects.

Proceedings under the Public Health Act.

Having dealt with the provisions of the Act for safeguarding the public health and preventing the spread of disease generally, we have now to consider the administrative practice by which those provisions are to be carried out, and although the method of serving notices and other matters have received some attention, it will be well to commence at the beginning, and set out the legal aspect of the inspector's work in the fullest detail.

The chief inspector collects from the books of his assistants such cases as seem to require the service of notice for abatement of nuisance; he thereupon serves upon the proper person, as the case may require, a notice which is called "preliminary" or "informal," and which has no statutory value.

It has acquired a greater importance in the Public Health (London) Act, as we shall see later on.

Should this notice fail to produce the desired result, the next duty of the inspector is to include the case in his list of cases for report to the next meeting of his committee; he will also be able to consult his medical officer, who will visit such cases as he may desire; all cases submitted to the committee should, as far as the size of the district will permit, have been visited by the chief inspector, but that would be impossible in great cities, and the report of the special district inspector would be taken. The committee will consider the case, and, if satisfied that a notice should issue, will direct the service of the same. The issue of this notice is usually confirmed by the Council in accepting the report of the sanitary committee. It has been

held that such approval is not absolutely necessary, but it is certainly the general practice to obtain it before the notice is served. This case and others which might also be cited, raises the whole question of the power of delegating powers to committees, and more properly belongs to Municipal Law than to the subject of this Appendix. But see section 200, with notes thereon.

The notice thus authorised by the Committee, and approved by the L.A., must be drawn in the form of Form A., Schedule IV., for all action taken under the provisions of the Act of 1875, or Acts incorporated therewith ; it must state clearly to whom it is addressed, and in what capacity—*i.e.*, owner, occupier, agent, etc.—and it must specify the nuisance in the words of the section contravened, and set out the nature of the work to be done, and a time within which it is required that it be done. It may be signed by either the clerk to the L.A., the Surveyor, the Inspector of Nuisances, and, as by sec. 191 the M.O. has all powers of an inspector of nuisances, by him. The signature of the clerk to the L.A. is sufficient authentication for any notice issued by the authority, and he only can properly sign notices under the Housing of the Working Classes Acts. In cases in which no special powers are conferred upon other officers, his signature is advisable—*e.g.*, under the Factory Acts.

Notices may be served either by delivery or by post ; in the latter case it is customary to register the letter as an evidence of delivery, if required.

The notice having been served, and thus, presumably, entered upon the records of the committee who authorised its service, if the nuisance complained of be not abated in the reasonable time allowed, it becomes the duty of the committee to take steps to enforce their requirements. This must be done within six months of the date at which the matter of such complaint arose. See sec. 252 now replaced in the same terms by sec. 11 of the Summary Jurisdiction Act, 1848 (11 and 12 Vict. c. 43). The only exception to this limitation is in the case of a continuing offence, as defined in sec. 158 of the P.H.A., 1875. The exact meaning of the words "continuing offence" is exceedingly obscure, and should only be decided by expert legal opinion in each individual case.

The inspector has now the important duty of preparing the case for the court. The Local Authority may appear by their clerk or by any officer authorised generally, or, in respect of any

special proceeding, by resolution of such authority (sec. 259). The documents required are as follows :—

1. Copy of notice served.
2. Copy of the Act and section upon which the action is based.
3. Where the Act is adoptive, copy of the resolution adopting it.
4. List of witnesses and *precis* of evidence to be given, setting out time and date of offence and inspection, and in simple language a description of the alleged offence, following, as far as possible, the words of the section contravened.

If it is proposed to call unofficial witnesses, great care should be taken as to the reliability of the evidence they propose to give.

Care must be taken to secure a Bench of Magistrates who are in no way connected with the L.A. It is quite true that section 258 seems to have been framed to remove any such incapacity on the part of members of the L.A., but this section must be entirely ignored, as it has been held to be of no effect. Where practicable, it is best to take all cases before a Stipendary Magistrate, especially if points of law are likely to be raised.

The court, if they are satisfied that the alleged nuisance exists, or that, even though abated for the moment it is likely to recur, may make an order in the terms of Form C., Schedule IV., or in a similar form authorised by the terms of the Summary Jurisdiction Act, 1879, for the execution of the works asked for in the notice, or for such works, distinctly specified in the order, as they may decide to be necessary to abate the nuisance, or to prevent its recurrence, or both, within a specified time, and, in addition, may, if they consider the case demands it, impose a penalty. It is, however, a common practice of courts, in place of making an order for specific works, to adjourn the case for fourteen days, to enable the defendant to abate the nuisance.

Every inspector should endeavour to perfect himself in the preparation of cases, and in his methods of giving evidence. The chief points in the witness box are to say as few words as possible, while including the essential facts, thus leaving but little opening for cross-examination, to use simple language, and, as far as possible, to avoid technicalities, to speak slowly and distinctly, giving time for the clerk or the Bench to make such notes as they may desire, and, above all, to cultivate the most detailed accuracy.

For those dissatisfied with the decisions of the Court of Summary

Jurisdiction an appeal lies to the Court of Quarter Sessions, and thence to the High Court (sec. 269). Such appeals are governed by the provisions of the Summary Jurisdiction Acts of 1879 and 1884.

There are also other remedies in certain cases--namely, appeals to the Local Government Board, and Arbitration, the latter remedy being open to any person "who sustains any damage" by reason of the exercise of any powers conferred by the Act of 1875. This procedure is governed by the provisions of the Arbitration Act, 1889, as far as it applies, and by sections 179, 180, and 181 of this Act, together with section 308.

There has been considerable doubt and consequent litigation as to the exact force of the words "damages sustained," and of the extent to which legal expenses incurred by the party aggrieved can be included in a claim for damages, but this belongs rather to the general study of law than to this summary of clauses.

The remainder of the Act deals with matters which, though of vital importance to the working of effective local government, have no concern with the duties and office of the sanitary inspector.

Attention should, however, be called to sec. 193, and inspectors must be warned against tampering in any way with contracts made by the L.A., or making any illicit profits; the section has been modified by the passing of the Public Health (Members and Officers) Act of 1885, but the need for caution remains the same.

In those cases in which the L.A., by the powers vested in them, have entered and done the work, it will have been noticed that they have power to recover the cost summarily, or, by special resolution, to declare the cost to be private improvement expenses.

Under sec. 213, where the L.A. have passed such a resolution, they may levy upon the owner of the property a private improvement rate which will repay the sum expended, together with not more than five per cent. on the cost, which rate shall be levied for a period not exceeding thirty years.

In considering the Acts which have been passed as amending Acts to the principal statute of 1875, it must be remembered that the following are only adoptive, and are only in force in those districts in which a special resolution has been passed adopting them:—

The Infectious Diseases (Prevention) Act may be adopted wholly by any district, whether urban, rural, or port, in the method prescribed by sec. 5 of the Act.

The Public Health Acts Amendment Act, 1890, of which Part I. is general, is adoptive for the rest of the Act. Part III., with which we are here concerned, can be adopted by any urban authority in the method prescribed in sec. 3, and rural authorities can adopt only those sections which are declared applicable to them by sec. 50 of the Act, fourteen in number. A rural authority can only adopt these sections or any of them by special application to the L.G.B. under sec. 5 of this Act and sec. 276 of the Act of 1875 relating to urban powers in rural districts.

The Public Health Acts Amendment Act, 1907, is also adoptive either in its entirety or by clauses.

Housing of the Working Classes.

The law governing the matter of the housing of the working classes is set forth in the Housing of the Working Classes Act, 1890 (which repealed and consolidated numerous previous Acts), the Housing, Town Planning, etc., Act, 1909, and the Housing, Town Planning, etc., Act, 1919, and these three Acts may be cited together as the Housing Acts, 1890 to 1919.

The 1890 Act is divided into three chief parts, the first, applicable only to urban districts, dealing with unhealthy areas, the second with unhealthy dwellings, and applicable to all districts, and the third, which is adoptive (made compulsory under the 1909 Act), with the provision by local authorities of working-class dwellings.

Under Part I. of the 1890 Act, it is the duty of an Urban Medical Officer of Health to make representations to his Authority regarding unhealthy areas, and the authority may prepare an improvement scheme, and apply to the Local Government Board for an enabling Order to carry it out. The Medical Officer of Health may make this representation on his own initiative or upon complaint from two or more justices of the peace within the district or twelve or more ratepayers.

The local authority may acquire property and compensate owners, and provision must be made for housing displaced inhabitants for which purpose the authority may acquire land.

Part II. of the Act, dealing with unhealthy dwellings, applies to all districts, and the Medical Officer of Health has to make the representation, either on his own initiative or on complaint from four or more householders. County Councils have power to act under this part of the Act in case of default on the part of rural authorities. Also, a representation by the Medical Officer of Health of a County to his Council, if forwarded by the Council to the Council of any urban or rural district, not being a borough, shall, for the purposes of Part II. of the Act, have a like effect as a representation from the Medical Officer of Health of the district.

Under Part III. of the Act, now operative in all cases, local authorities may provide " lodging houses for the working classes," including cottages containing one or several tenements, and, with this object, may purchase land and houses.

The remaining Parts of the Act, IV. to VII., deal chiefly with procedure.

The Housing, Town Planning, etc., Act, 1909, extends the 1890 Act. It (sec. 1) makes Part III. of that Act operative in all districts. Under sec. 10, the Local Government Board, on complaint from a County Council, a Parish Council, a parish meeting, or four inhabitant householders in the case of a country district, and, in the case of any other district, from four inhabitant householders, may, by order, after enquiry, compel authorities to act under Parts II. and III. of the principal Act, and, if an authority of a country district then fails to carry out the order, the Local Government Board may transfer the duty to the County Council with the consent of that body.

The Local Government Board may also (sec. II.) make an order in case of defaulting authorities as to Parts I. and II. of the principal Act, which order may be enforced by mandamus. Further (sec. 12), in a rural area, on complaint to the County Council by a Parish Council, a parish meeting, or four inhabitant householders that the authority are in default as regards Part III. of the Act, the County Council, if satisfied on public enquiry as to the truth of the representation, may themselves exercise the powers of the defaulting authority. Also (sec. 13), in the case of a rural district, if the County Council thinks it expedient that they should exercise any of the powers of a rural district under Part III. of the principal Act, they may apply for such power to the Local Government Board, who may make an order accordingly.

Sections 14 and 15 of this Act should be carefully studied by the Inspector, in conjunction with Section 75 of the principal Act. The last-mentioned section provides that it shall be an implied condition (after August 14th, 1885), on letting a house or part of a house for habitation by persons of the working classes, that the house is in all respects "reasonably fit for human habitation." Section 14 of the 1909 Act defines the houses to which this condition applies, and by sec. 15 a further obligation is placed on the landlord—namely, that he shall keep the houses in all respects reasonably fit for habitation, failing which (*a*) the authority may make a closing order, or (*b*) by written notice require the landlord, within a reasonable time, not being less than 21 days, specified in the notice, to carry out certain specified works, upon which (*c*) the landlord may, within 21 days declare his intention of closing the house, and, thereupon, a closing order shall be deemed to have become operative in respect of such house. Failing compliance by the landlord, the authority may do the work at his cost, but he has the right to appeal to the Local Government Board.

Another provision of the 1909 Act, which is of importance to the Inspector, is the duty imposed on every local authority within the meaning of Part II. of the principal Act to cause to be made from time to time (sec. 17), an inspection of their district with a view to closing and demolition orders, and when a demolition order (sec. 18) has remained operative for three months, the question of demolition must be considered, the owner being given an opportunity of being heard, and he also has the right of appeal to the Local Government Board.

The erection of back-to-back houses is unlawful in all districts (sec. 43), with certain reservations as regards tenement houses and houses abutting on any streets, the plans of which have been approved before May 1st, 1909, in any district in which, at the passing of the Act, any local Act or bye-laws are in force permitting the erection of back-to-back houses. The Act also (sec. 44) enables the Local Government Board to revoke such bye-laws as they may consider unreasonably impede the erection of dwellings for the working classes.

Part II. of the 1909 Act relates to town planning and should be read in conjunction with Part II. of the Act of 1919. By the latter Act the preparation of town planning schemes has been made obligatory on certain authorities and on other authorities if so directed by the Local Government Board (see post).

The Housing, Town Planning, etc., Act, 1919, adds to the powers and responsibilities of district councils under the Housing Acts. Authorities within the meaning of Part III. of the 1890 Act must consider and, within three months of the passing of the Act, or within three months after notice from the Local Government Board, submit a housing scheme (sec. 1). Should an authority fail in this respect the Local Government Board may, after the parties have been heard, direct the County Council to submit and carry out a scheme (sec. 3), or the Local Government Board itself may undertake the duty (sec. 4). Should a scheme not comply in certain respects with local building bye-laws, these, with the approval of the Local Government Board, may be disregarded (sec. 26). Further, sec. 26 extends the matters concerning which bye-laws may be made under the Public Health Act, 1875, and should be carefully studied by the Inspector. Section 28 makes it obligatory on an owner of a house to keep it in proper repair, and if he claims that the house cannot be made habitable without reconstruction, the authority may issue a closing order. The tenant of a working class house has (sec. 29) to be informed, by entry on the rent book or in writing, of the name and address of the Medical Officer of Health of the district and of the landlord. If a house in respect of which a closing order is in force is let, or an attempt is made to let it, a penalty not exceeding twenty pounds may, on summary conviction, be imposed (sec. 32).

Under Part II. of this Act the necessity of sanction by the Local Government Board to prepare a town planning scheme is abolished (sec. 42), and (sec. 43) the Local Government Board may make regulations for the carrying out of such a scheme. Further (sec. 46), the council of every borough or other urban district with a population of over 20,000 must within three years, commencing January, 1923, submit a town planning scheme to the Local Government Board, any regulations, however, made by the Board may be annulled by Parliament. Also (sec. 47), the Local Government Board, after enquiry, may require a scheme to be submitted, and may enforce its carrying out efficiently, failing which, the Local Government Board may themselves undertake the work, or, in the case of a borough or other urban district, the population of which is less than 20,000, or a rural district, may empower the County Council to act in place of the local authority and at the latter's expense.

In carrying out systematic inspections for the purpose of this

Act, the inspector will frequently find that the defects met with can more readily be remedied as nuisances under the Public Health Act, 1875, and, in determining this, he must exercise his common sense. He must approach each case with an open mind, and avoid coming to any determination until he has completed his detailed inspection. He will then be in a position to form an opinion regarding the gravity of the defects considered singly or collectively, and be able to determine whether the property should be dealt with under the Act by a closing order, and he will further be able to specify the work necessary to be done to render the house habitable, or give his reasons for reporting that nothing short of demolition will meet the case.

In order to save time and avoid the risk of overlooking any points, it is desirable that the inspection should be conducted systematically according to a fixed plan, beginning with the outside and afterwards noting the interior conditions floor by floor from cellar or basement to roof. The inspector should carry a note-book, so arranged as regards headings as to simplify his work and prevent him from overlooking any matters, and there should be ample room for remarks. It will be found that the card index system is a convenient one for the keeping of permanent records of every house inspected.

The Pollution of Rivers.

The Rivers' Pollution Prevention Acts of 1876 and 1893 are administered by local authorities and County Councils, and, when specially constituted, by rivers boards. Proceedings are taken in the County Court, but there is an appeal to the High Court. Before such proceedings can be taken in the case of manufacturing refuse the permission of the Local Government Board must first be obtained; on the other hand, facilities must be afforded to manufacturers by local authorities to connect with their sewers so long as injury to the sewers or disposal works will not thus be brought about.

As already stated (p. 100), streams must not be polluted by gas washings (sec. 68, P.H.A.) under a penalty of £200 and £20 per diem.

It would also appear that the pollution of a river by gas

washings is a nuisance at Common Law for which an indictment will lie.

The powers conferred under the Acts are further extended by sec. 47 of the P.H.A.A., 1890, which prohibits any person from throwing into any river, stream, or watercourse, any cinders, ashes, bricks, stone, rubbish, dust, filth, or other matter likely to cause annoyance. Penalty—forty shillings for every offence; procedure—summary.

The Canal Boats Acts, 1877 and 1884.

The registration of all canal boats was first enacted by sec. 1 of the Act of 1877, the registration authorities being the L.A. of those districts through which the canal passes or which abut on the canal, all forms of sanitary authority whether urban, rural, or port being included.

The L.G.B. have power to make regulations, and such regulations were made on March 20th, 1878, together with the necessary forms for report, registration, etc.

The registration district must include a school district, so that the children belonging to the boat shall come under some education authority.

The powers of this Act were extended by the Act of 1884, and by that the system was brought into regular working.

There is now an inspector of canal boats appointed by the L.G.B., who visits regularly all the sanitary authorities which are concerned with canals; these authorities now appoint an authorised person (not necessarily the inspector of nuisances), who is responsible to the L.A., and must make an annual report to be sent to the L.G.B. within the first twenty-one days of the year; this report is presented by the inspector to the L.A., and by them forwarded to the L.G.B. It must deal with the following points:—

"1. The arrangements made for the inspection of boats, and the remuneration of the inspector.

"2. The number of boats inspected in the year, and the condition of the boats and their occupants as regards the matters dealt with in the Acts and regulations.

"3. Any infringements of the Acts and regulations with respect to (*a*) registration, (*b*) notification of change of master, (*c*) absence of certificates, (*d*) marking, (*e*) overcrowding, (*f*) separation of the sexes, (*g*) cleanliness and ventilation, (*h*) removal of bilge water, (*i*) notification of infectious diseases, (*j*) refusal of admittance to inspector.

"4. Legal proceedings taken in respect of any such infringements, and penalties inflicted.

"5. Any other steps taken to secure compliance with the Acts and regulations as regards such infringements.

"6. Cases of infectious disease dealt with, and measures of isolation adopted.

"7. Detention of boats for cleansing and disinfection; and, in the case of registration authorities—

"8. The number of boats on the register.

"9. The number registered in 1889, distinguishing the cases in which fresh registration has been rendered necessary by structural alterations in boats previously registered.

The Acts confer a power of entry upon a properly authorised person to inspect in cases of suspected infectious disease by day (*i.e.*, between 9 a.m. and 6 p.m.), and for an inspector to enter to enquire, if necessary, into a breach of the regulations, and, if necessary, to detain the boat.

Where an after-cabin is used as a dwelling, there must be not less than 180 cubic feet of free air space; and a fore-cabin must contain not less than 80 cubic feet of free air space.

Cases of infectious disease occurring on board must be notified by the master of the boat to the (nearest) sanitary authority, who shall take such action as they may think necessary.

It is as well to quote the definitions given in the Act :—

"Canal" includes any river, inland navigation, lake, or water, being within the body of a county, whether or not it is within the ebb and flow of the tide.

"Canal boat" means any vessel, however propelled, which is used for the conveyance of goods along a canal as above defined, and which is not a ship duly registered under the Merchant Shipping Act, 1854, and the Acts amending the same.

"Owner" includes the person who, though only the hirer of the canal boat, appoints the master and other persons working the said boat.

"Master," in relation to a canal boat, means the person for the time being having charge or command of the boat.

The Sale of Food and Drugs.

In no department of public health work is it more essential that an inspector shall adhere to the strict letter of the law than in discharging his duties under the Sale of Food and Drugs Acts. In most of the cases in which proceedings are taken in court the defendant is legally represented, and, apart altogether from

the merits of the case, every advantage is taken of the smallest legal technicality in order to obtain an acquittal, a course which, unfortunately, is too often successful. It behoves an inspector, therefore, to study most carefully the procedure to be followed.

Where there is not a separate inspector appointed under these Acts—namely, the Sale of Food and Drugs Act, 1875, the Sale of Food and Drugs Amendment Act, 1879, the Sale of Food and Drugs Act, 1899, and the Margarine Act, 1887—the duties are frequently assigned to the sanitary inspector or to one of his assistants.

The following definitions occur in the Acts :—

"Food" shall include every article used for food or drink by man, other than drugs or water; any article which ordinarily enters into or is used in the composition or preparation of human food; and shall also include flavouring matters and condiments (1899, sec. 26).

"Drugs" shall include medicine for internal or external use (1875, sec. 2).

"Butter" means the substance usually known as butter, made exclusively from milk or cream, or both, with or without salt or other preservative, and with or without the addition of colouring matter (1887, sec. 3).

"Cheese" means the substance usually known as cheese, containing no fat derived otherwise than from milk (1899, sec. 25).

"Margarine" means all substances, whether compounds or otherwise, prepared in imitation of butter, and whether mixed with butter or not, and no such substance shall be lawfully sold except under the name of margarine and under the conditions set forth in this Act (1887, sec. 3).

"Margarine cheese" means any substance, whether compound or otherwise, which is prepared in imitation of cheese and which contains fat not derived from milk (1899, sec. 25).

After all it remains a question of fact for the magistrate to find whether an article comes within the definition of either food or drug, as will be seen from the cases quoted in the text-books.

Under these Acts it is an offence "to mix, colour, stain, or powder any article of food so as to render it injurious to health, or any drug so as to affect injuriously its quality or potency," to the prejudice of the purchaser, whether he be buying merely for analysis or not, and penalties are provided.

It is further forbidden to sell to the prejudice of the purchaser any article of food or any drug not of the nature, substance, and

quality demanded, or to abstract from an article of food any part of it so as to affect injuriously its quality, substance, or nature.

Various doubts have been cleared away by the amending Acts; thus it is no longer a defence to say that if the purchaser only bought for analysis it was not to his prejudice; the list of foods has been widened as far as possible; and the putting forward of a warranty has been much safeguarded by sec. 20, F.D., 1899.

The procedure is for the inspector to send into the shop his assistant to buy the sample required; after the purchase is completed the inspector enters and states that the purchase is for analysis and then divides the sample into three parts, one for the vendor, one for the public analyst, and one to be produced in court if required.

The inspector has a right to purchase any article which is on sale, and it is an offence to refuse to sell to him the particular article he calls for if it is there on sale.

Proceedings must be instituted within twenty-eight days of the purchase, and the summons, which must be accompanied by a copy of the analyst's certificate, must not be made returnable in less time than fourteen days from the day on which it is served (1875, sec. 19).

The offence created by sec. 6 shall not be deemed an offence in the following cases :—

"1. Where any matter or ingredient not injurious to health has been added to the food or drug, because the same is required for the production or preparation thereof as an article of commerce in a state fit for carriage or consumption, and not fraudulently to increase the bulk, weight, or measure of the food or drug, or to conceal the inferior quality thereof.

"2. Where the food or drug is a proprietary medicine, or is the subject of a patent in force, and is supplied in the state required by the specification of the patent.

"3. Where the food or drug is compounded and not labelled as mixed at the time of sale.

"4. Where the food or drug is unavoidably mixed with some extraneous matter in the process of collection or preparation."

Under sec. 25 of the 1875 Act, the defendant was entitled to plead "warranty" on showing (1) that he purchased the article as the same in nature, substance, and quality as that demanded of him by the purchaser; (2) that he purchased the article with a written warranty to that effect; (3) that he had no reason to believe at the time when he sold it that the article was otherwise; (4) that he sold it in the same state as when he purchased it.

And now by sec. 20 of the Act of 1899, if he proposes to rely

upon the plea of warranty he must (1) give notice to the purchaser to that effect within seven days of the service of the summons; (2) send a copy of the warranty and the name and address of the person from whom he received it; and (3) give notice of a like character to the person from whom he received it. If the case be one of a warranty from outside the United Kingdom he must show that he took reasonable steps to satisfy himself of the accuracy of the warranty.

Further proceedings against the person giving the warranty can be taken in the same court as the original proceedings and not at the place from which the warranty came.

Samples of milk may be taken in course of delivery, in which case the procedure differs from that laid down in sec. 14 of the primary Act. In this case instead of dividing the sample into three parts it is the duty of the officer who takes it to "forward by registered parcel or otherwise a portion of the sample marked, sealed, and fastened up to the consignor if his name and address appear on the can or package sampled."

Before the passing of the Act of 1899, in which this rule is made, doubts had arisen as to the proper procedure in the case of samples taken in course of delivery.

The inspector must remember that a sample cannot be mixed for the purpose of obtaining a sufficient quantity for analysis, and that where the article sold is in too small a quantity to admit of subdivision, as in the case of pennyworths of camphorated oil or seidlitz powders, it has been found impossible to carry out the provisions of the Acts. *De minimis non curat lex.*

The Public Health (Milk and Cream) Regulations, 1912.

Under the Public Health (Regulations as to Food) Act, 1907, the L.G.B. have power to make regulations governing "the importation, preparation, storage, and distribution of articles of food or drink (other than drugs or water) intended for sale for human consumption"; accordingly the Board have issued regulations as to the addition of preservatives and other foreign substances to milk and cream, entitled "The Public Health (Milk and Cream) Regulations, 1912." The duty of administering the Regulations (except as regards imported milk and cream when the officers of Custom and Excise enforce the Regulations) has been placed upon the authorities who administer the Sale of Food and Drugs Acts,

As regards milk, Article III. makes it an offence to add, or to order or permit a person to add, any preservative substance, neither can anyone offer for sale, or have in his possession for the purpose of sale, milk to which a preservative has been added.

As regards cream, no thickening substance (cane or beet sugar not to be considered such) may be added under any circumstances, and no preservative may be added to cream containing less than 35 per cent. by weight of milk fat. If the cream contains 35 per cent. or more of milk fat, there may be added to it one or other of the following preservatives—viz., boric acid, borax, or a mixture of these substances, or hydrogen peroxide—providing certain conditions regarding labelling, etc., are complied with, as follows:—(*a*) No advertisement or trade list used in connection with the sale of preserved cream for human consumption shall contain words which might imply that the article does not contain a preservative; on the contrary, it should be described as preserved cream; (*b*) the receptacle containing such article shall have an adhesive "declaratory lable" attached to it of a specified size, printed on a white ground in black type of a specified size, as follows:—Preserved cream containing boric acid not exceeding 0·4 per cent. (Amending Regulations, 1917), or preserved cream (peroxide). In the case of public refreshment rooms, when preserved cream is used, the receptacle need not be labelled, but an easily legible notice to that effect must be posted up, or, as alternative, either a statement to that effect must appear conspicuously on every bill of fare exhibited to customers, or similar intimation given by some other adequate means. The Amending Regulations, 1917, also require that preserved cream shall be labelled "Not suitable for infants or invalids."

Samples shall be obtained and dealt with in the usual manner, but before the authority determines to institute proceedings against a person, such person shall be afforded an opportunity of furnishing an explanation in writing or otherwise.

The Factory and Workshop Act, 1901.

This Act has replaced and consolidated the Acts on the subject previously existing, and the duties of the sanitary authority in conjunction with and in relation to the factory inspector appointed by the central body are very important.

Factories have already been alluded to in connection with sec. 91 of the P.H.A., 1875, but by sec. 1 of this Act all factories

are excluded from the operation of that section except domestic factories.

As regards sanitary conveniences in factories, to avoid repetition attention is directed to the particulars set forth in referring to sec. 38 of the P.H.A., as influenced by this Act and the P.H.A.A.

The factories to which the Factory Act especially applies are fully set out in the definitions of the Act, sec. 149, which are too lengthy for extended quotation. It may, however, be understood that the real difference between a factory and a workshop is the employment of steam, water, or other mechanical power to move machinery, in the former.

Putting aside the factories thus excepted, sec. 2 enacts that every other sort of factory, every workshop or workplace must be kept clean, properly ventilated, and not overcrowded; further, every workshop or workplace must be kept free from effluvia arising from any drain, water-closet, earth-closet, privy, urinal, or other nuisance, and, if otherwise, can be dealt with summarily under the P.H.A. powers.

The sanitary inspector (or M.O.H.) can give a certificate upon which the L.A. shall issue a notice for limewashing, cleansing, or whitewashing, as the case may require, and in default may enter, do the work, and recover the cost; there are also penalties.

The Act requires a cubic space per head of not less than 250 cubic feet, or if overtime be worked not less than 400 cubic feet, and the number of persons employed in every room must be shown on a notice hung up in the room.

When the L.A. make default in remedying any sanitary defect in a workshop or workplace it is open to the factory inspector himself to take proceedings at the cost of the L.A. Further than that he reports to the clerk of the L.A. all cases in which the closet accommodation is insufficient or defective, and for the purposes of enquiring into such condition he may take with him into the factory or workshop the M.O.H., or sanitary inspector, or any other officer who may be useful to him (perhaps the surveyor); it shall be the duty of the L.A., on receiving the report, to take the necessary action and report to the inspector the result.

Other points which belong to the L.A. in workshops are ventilation, the proper drainage of floors, and the adequate provision of closet accommodation for both sexes.

The provision of proper means of escape in case of fire in all factories and workshops in which more than forty persons are employed is now the care of the L.A., who shall (through their

surveyor) examine such factory or workshop and, if satisfied, give the owner or occupier a certificate to that effect, and in default shall serve a notice requiring efficient means of escape to be provided.

Sec. 18 confers special powers to take proceedings upon the factory inspector, and cases arise in which, by concerted action of the inspector and the sanitary department, this section will be found useful. It applies to any factory or workshop in such a condition that the process carried on therein cannot be carried on without danger to health or to life and limb, and enables a justice to close the place until such works have been executed as to remove the danger.

The inspector must be specially authorised (1) by the L.A and (2) by the chief inspector of factories to take this action, and the result is much more drastic than could be obtained by the use of other powers.

Bakehouses constitute the most important of the workshops which it is the duty of the sanitary department to supervise, and are regulated by secs. 97-102 of the Act.

"Retail bakehouse" means any bakehouse or place, not being a factory, the bread, biscuits, or confectionery baked in which are sold not wholesale but by retail in some shop or place occupied with the bakehouse.

"Domestic factory" and "domestic workshop" mean a private house, room, or place which, though used as a dwelling, is by reason of the work carried on there a factory, or a workshop as the case may be, and in which neither steam, water, nor other mechanical power is used, and in which the only persons employed are members of the same family dwelling there (*e.g.*, the process of bookbinding, Schedule 6, Part 1).

The principal provisions as to bakehouses are as follows :—

1. A water-closet, earth-closet, privy, or ashpit must not communicate directly with the bakehouse.

2. The water cistern for the bakehouse must be quite separate from that supplying water to a water-closet.

3. A drain or pipe for carrying off sewage or fæcal matter must not have an opening within the bakehouse.

4. The walls and ceilings must be painted with oil or varnished, and be cleaned every six months, or be limewashed and renewed every six months.

5. No sleeping-place shall be permitted on the same level and as a part of the same building unless it is effectually separated from the bakehouse and effectively ventilated.

For all inspectorial purposes it may be taken that the powers of entry in the P.H.A. are ample for this Act also, except in the special cases already noted, but to prevent doubt, powers are conferred by sec. 125 upon the district council and their officers to enter, inspect, and take legal proceedings.*

Dairies, Cowsheds, and Milkshops.

The Regulation of Dairies, Cowsheds, and Milkshops was originally vested in the Privy Council under the provisions of the Contagious Diseases (Animals) Act, 1878, sec. 34, but was transferred to the L.G.B. by sec. 9 of the Amending Act of 1886. Both these Acts, with the exception of the two sections above mentioned, have been superseded and repealed by the Act of 1894, with which we are not here concerned. Under the above sec. 34 the L.G.B. have power to make orders for the following purposes :—

1. For the registration of all persons carrying on the trade of cowkeepers, dairymen, or purveyors of milk.
2. For the inspection of cattle in dairies, and for prescribing and regulating the lighting, ventilation, cleansing, drainage, and water supply of dairies and cowsheds in the occupation of persons following the trade of cowkeepers or dairymen.
3. For securing the cleanliness of milk-stores, milkshops, and of milk-vessels used for containing milk for sale by such persons.
4. For prescribing precautions to be taken for protecting milk against infection or contamination.
5. For authorising a local authority to make regulations for the purposes aforesaid, or any of them, subject to such conditions, if any, as the L.G.B. prescribe.

A man keeping cows to supply milk to his own household and only occasionally supplying an outsider does not come within the Act.

No special power is given to appoint an inspector for this special work, but the work will necessarily devolve upon the M.O.H. and the inspector, and it may be necessary to appoint a special officer for the purpose. A rural authority may appoint as many inspectors of nuisances as it pleases (sec. 190 P.H.A., 1875), and an urban authority, though it may only appoint one inspector of nuisances, may appoint as many officers as are necessary to carry out the Public Health Acts. The effect of this

* At the end of this Appendix will be found an official blank table approved by the Secretary of State for making returns under this Act.

has been that in one urban district an inspector of nuisances has claimed to resign his position as inspector of nuisances without giving up his appointment under these orders. There is conferred upon the L.A. and their officers a right of entry as under the P.H.A., sec. 102, and an officer may apply for a justice's order if admission is refused him.

The orders made under sec. 34 and still in force are dated June 15, 1885, having been adopted by the L.G.B. by an amending order, and the chief provisions therein are here summarised :—

Every cowkeeper, dairyman, or purveyor of milk shall apply to the L.A. for registration before commencing business, and the application shall be granted ; but the L.A. may require that in granting such application proper provision shall be made for lighting, air space, and ventilation, and for proper cleansing, drainage, and water supply. Although the application must be granted the applicant cannot commence to occupy any premises for these purposes without giving a month's notice to the authority. It will thus be seen that the registration, unlike the case of a slaughter-house, is a personal licence to carry on trade of this character in any place which shall be subsequently approved as suitable by the L.A.

Special provisions are made for the cleanliness of milk-vessels, for the health and good condition of the cattle, and for the protection of the milk against infection and contamination ; and it is an offence to permit any person suffering from a dangerous infectious disorder to have anything to do with the cows or with the milk. This may be taken to include smallpox, scarlet fever, typhoid fever, diphtheria, and, in certain cases, tuberculosis.

No water-closet, etc., shall be permitted to remain in direct communication with, or to ventilate into, any dairy or any room used as a store-room for milk or milkshop, nor may milk be stored in any room which is used as a sleeping apartment.

It is unlawful to keep swine in a cowshed or place for keeping cows, or in any place where milk is stored. Further, where the cows are found to be diseased it is penal to use the milk from them, or to mix with other milk, for human food, or even for the food of swine or other animals, unless in the latter case it has been previously boiled.

The L.A. are given power to make regulations for the better carrying out of this order, and the L.G.B. has issued a series of model regulations, to which the student is referred, as being too long for quotation. They provide for the following points :—

(*a*) For the inspection of cattle in dairies.

(*b*) For prescribing and regulating the lighting, ventilation, cleansing, drainage, and water supply of dairies and cowsheds in the occupation of persons following the trade of cowkeepers or dairymen.

(*c*) For securing the cleanliness of milk-stores, milkshops, and of milk-vessels used for containing milk for sale by such persons.

(*d*) For prescribing precautions to be taken, by purveyors of milk and persons selling milk by retail, against infection or contamination.

All public health officers are aware that milk, owing to the present methods of production and distribution, is one of the dirtiest articles of food, in place of being, as it well might be with ordinary care, one of the cleanest. Most of the impurities in milk arise from the dirty state of the cows and the cowsheds, and until public opinion is properly roused, and the true facts are brought home to the consumers, the mass of the producers will make no attempt to improve matters. This is equally true as regards tuberculous milk, the present method of housing cows being a very potent predisposing cause. The inspector, therefore, should do his utmost to hasten the coming of the time when the public will be able to purchase milk which is clean and free from tubercle bacilli. He can do much in this direction by a determined effort to bring about a radical improvement in the lighting and ventilation of the cowsheds in his district, and it is important to remember that no amount of cubic space will compensate for the absence of free cross ventilation.

There remains for consideration in this connection sec. 4 of the Infectious Diseases Prevention Act, 1890, which is here appended in full :—

"In case the medical officer of health is in possession of evidence that any person in the district is suffering from infectious disease attributable to milk supplied within the district from any dairy situate within or without the district, or that the consumption of milk from such dairy is likely to cause infectious disease to any person residing in the district, such medical officer shall, if authorised in that behalf by an order of a justice having jurisdiction in the place where such dairy is situate, have power to inspect such dairy, and if accompanied by a veterinary inspector or some other properly qualified veterinary surgeon to inspect the animals therein, and if on such inspection the medical officer of health shall be of opinion that infectious disease is caused from consumption of the milk supplied therefrom, he shall report thereon to the local authority, and his report shall be accompanied by any report furnished to him by the said veterinary inspector or veterinary surgeon, and the local authority may thereupon give notice to the dairyman to appear before them within such time, not less than twenty-four hours, as may be specified in the notice, to show cause why an order should not be made requiring him not to supply any

milk therefrom within the district until such order has been withdrawn by the local authority, and if, in the opinion of the local authority, he fails to show such cause, then the local authority may make such order as aforesaid; and the local authority shall forthwith give notice of the facts to the sanitary authority and county council (if any) of the district or county in which such dairy is situate, and also to the Local Government Board. An order made by a local authority in pursuance of this section shall be forthwith withdrawn on the local authority or the medical officer of health on its behalf being satisfied that the milk supply has been changed, or that the cause of the infection has been removed. Any person refusing to permit the medical officer of health on the production of such order as aforesaid to inspect any dairy, or if so accompanied as aforesaid to inspect the animals kept there, or after any such order not to supply milk as aforesaid has been given, supplying any milk within the district in contravention of such order, or selling it for consumption therein, shall be deemed guilty of an offence against this Act. Provided always, that proceedings in respect of such offence shall be taken before the justices of the peace having jurisdiction in the place where the said dairy is situate. Provided also, that no dairyman shall be liable to an action for breach of contract if the breach be due to an order from the local authority under this Act."

A "Dairy" is defined as including:—

"Any farm, farm-house, cowshed, milk-store, milkshop, or other place from which milk is supplied or in which milk is kept for purposes of sale."

"Dairyman" includes any cowkeeper, purveyor of milk, or occupier of a dairy.

A veterinary inspector is one appointed under the Contagious Diseases Animals Act, 1878, the provisions of which Act are further safeguarded in this Act (sec. 24).

"Disease," in the Dairies, Cowsheds, and Milkshops Order, includes the diseases originally laid down in the Act of 1878, and which are cattle plague, pleuro-pneumonia, foot-and-mouth disease, and tuberculosis of the udder, but these have been extended in the Milk and Dairies (Extension) Act, 1915, which, however, has not yet come into operation.

It has long been realised that the law governing the production and distribution of milk required strengthening, and this has at last been accomplished by the passing of Milk and Dairies (Consolidation) Act, 1915, which, however, does not come into operation until "such date not being later than the expiration of one year after the termination of the present war as the Local Government Board may by order appoint."

This Act supersedes a less comprehensive measure, the Milk and Dairies Act, 1914, which, however, never came into operation, having been twice postponed—namely, by the Milk and Dairies Postponement Order, 1914, and the Milk and Dairies Postponement Act, 1915.

Although the Consolidation Act of 1915 is not yet in operation, in view of its coming into operation it is desirable that its provisions should be summarised.

Sec. 1 (1) empowers the L.G.B. to make orders (special or general) for all or any of the following purposes:—

(*a*) For the registration of persons carrying on the trade of dairymen;

(*b*) for the registration of all dairies;

(*c*) for the inspection of cattle in dairies;

(*d*) for the inspection by authorised persons of dairies and persons in and about dairies who have access to the milk or milk receptacles;

(*e*) for prescribing and regulating the lighting, ventilation, cleansing, drainage, and water supply of dairies;

(*f*) for securing the cleanliness of milk-stores, milkshops, and milk-vessels;

(*g*) for protecting milk against infection or contamination;

(*h*) for preventing danger to health from the sale of, or use in the manufacture of products for human consumption, of infected, contaminated, or dirty milk;

(*i*) for regulating the cooling, conveyance, and distribution of milk for similar uses;

(*j*) as to the labelling, marking, or identification, and the sealing or closing of churns, vessels, and other milk receptacles;

(*k*) for prohibiting the addition of colouring matter, and for prohibiting or regulating any other artificial treatment;

(*l*) for authorising the use of the designation "certified milk," and prescribing the conditions attaching to such designation;

(*m*) for authorising a local authority to make regulations for the purposes aforesaid, or any of them, subject to such conditions (if any) as the L.G.B. prescribe.

Sec. 1 (2) authorises (if laid down in a Milk and Dairies Order) a person making an inspection "to require any cow to be milked in his presence, and to take samples of the milk, and to require that the milk from any particular teat shall be kept separate, and to take separate samples thereof."

Sec. 2 provides for right of entry as under the Public Health Act, 1875, with the proviso that the permission of the authority under the Diseases of Animals Acts, 1894 to 1914, must be obtained in the case of any cowshed or other place in which an animal affected with any disease to which these Acts apply is kept, and

which is situated in a place declared under those Acts to be infected with such disease.

Secs. 3 and 4 make it obligatory on medical officers of health of counties and county boroughs, and, if the L.G.B. so direct, the medical officers of health of non-county boroughs which are authorised for the purposes of the Diseases of Animals Acts, 1894 to 1914, to inspect, report, and take such steps as are authorised under the first schedule of the Act, if they should be of opinion that tuberculosis is caused, or is likely to be caused, by the consumption of milk supplied from any dairy within their respective districts. If the suspected milk comes from an outside area, the M.O.H. should give notice to the M.O.H. of that area, who, on receipt of such notice, must inspect and make enquiry, giving sufficient notice to the M.O.H. from whom the information came of the time of such inspection, and supplying him with copies of any reports.

Sec. 5 prohibits the sale of tuberculous milk and milk from cows suffering from (1) emaciation due to tuberculosis, (2) tuberculosis of the udder, (3) acute inflammation of the udder, (4) actinomycosis of the udder, (5) anthrax, (6) foot-and-mouth disease, (7) suppuration of the udder, and (8) any other disease affecting cows which by a Milk and Dairies Order is declared to be a disease for the purpose of this section 5 of the Act.

Sec. 6 provides that any person selling milk in a highway or place of public resort shall have his name and address conspicuously inscribed on the vehicle or receptacle.

Sec. 7 provides that every tin or other receptacle containing condensed, separated, or skimmed milk must be clearly labelled "Machine-skimmed Milk," or "Skimmed Milk," as the case may be.

Sec. 8 (1) provides for the taking of samples of milk at any time before it is delivered to the consumer by "an inspector of the Local Government Board, or the medical officer of health of a local authority, or any person provided with and, if required, exhibiting an authority in writing from such an inspector or from the local authority or medical officer of health." The subsequent sub-sections (2-6) set forth the procedure to be followed on taking action upon a report on a bacteriological or other examination of such a sample, and also provide for samples being collected by authorised officers of other local authorities, being authorities for the purpose of the Sale of Food and Drugs Acts, on being requested to do so by the authorised officers of districts in which the milk is being sold.

Sec. 9 amends the provisions of the Sale of Food and Drugs Acts, 1875 to 1907, in reference to the taking of samples of milk and any proceedings in connection therewith. It enacts that a purveyor, on being required to do so, must give the name and address of the seller or consignor, and that samples may be taken in course of transit or delivery from such seller or consignor, and proceedings may be taken against him, in place of, or in addition to, the purveyor. The owner of the cows, however, may, within sixty hours after the sample of milk was procured, serve on the local authority a notice requesting them to take a sample of milk from a corresponding milking of the cows to which the provisions of the section shall apply, if in the opinion of person taking the sample it is a fair sample of the milk of the cows when properly and fully milked.

The remaining sections of the Act deal with (1) the appointment of veterinary inspectors, (2) regulations as to imported milk, (3) establishment of milk depôts, (4) enforcement of duties of local authorities, (5) penalty for obstruction, (6) the holding of L.G.B. inquiries, (7) the delegation of powers to committees, (8) any inspection of cattle to be carried out by a veterinary inspector or other qualified veterinary surgeon, (9) compensation to sanitary officers and servants, (10) expenses, (11) provisions as to offences, (12) interpretation of terms, and (13) the application of the Act to London. The Act does not extend to Scotland or Ireland.

The enactments repelled are set forth in the fourth schedule, but, as the Act is not yet in operation, it is hardly necessary to enumerate these.

The execution of duties under the Contagious Diseases Act of 1894 do not usually fall within the sphere of the sanitary department, but are assigned to the police; the more important are those connected with swine fever and the issuing of orders for the removal of store pigs from one district to another, the detection of anthrax, and the destruction and proper treatment of the carcase. The consulting authority is naturally the veterinary surgeon employed by the L.A.

Rag Flock Act, 1911.

By sub-section (1) of sec. 1 of this Act it is enacted as follows :—

" It shall not be lawful for any person to sell, or have in his possession for sale, flock manufactured from rags, or to use for the purpose of making

any article of upholstery, cushions, or bedding flock manufactured from rags, or to have in his possession flock manufactured from rags intended to be used for any such purpose, unless the flock conforms to such standard of cleanliness as may be prescribed by regulations to be made by the Local Government Board, and, if any person sells or uses or has in his possession flock in contravention of this Act, he shall be liable on summary conviction to a fine not exceeding, in the case of a first offence, ten pounds, or in the case of a second or subsequent offence, fifty pounds."

The L.G.B. have accordingly made an Order prescribing regulations known as "The Rag and Flock Regulations, 1912," which came into operation on July 1st of that year, as follows :—

"Flock shall be deemed to conform to the standard of cleanliness for the purpose of sub-section (1) of section 1 of the Act when the amount of soluble chlorine, in the form of chlorides, removed by thorough washing with distilled water at a temperature not exceeding 25 degrees Centigrade from not less than 40 grammes of a well-mixed sample of flock, does not exceed 30 parts of chlorine in 100,000 parts of the flock."

It is very important that the provisions of this Act shall be taken advantage of, and it will be the inspector's duty to collect samples for analysis should he have reason to suspect that they are not being complied with.

Bye-laws and Regulations.

A bye-law has been defined as a law made by some authority less than Parliament in respect of a matter specially referred to the authority by statute and not provided for by the general law of the land.

It must be consistent with the general law, and must provide something in addition to it—*i.e.*, it must not merely re-enact the terms of a statute, it must not be ambiguous, must prescribe or enjoin or prohibit a definite action, must contain a definite penalty for its contravention, and must come within the scope of the powers under which it is made, or else it may be *ultra vires*, and consequently bad.

Under the Public Health Act bye-laws are made as follows :—

They must be under the common seal of the authority, and are subject to the confirmation of the L.G.B. before they can become operative. It is the duty of the L.A. to give public notice of their intention to apply for confirmation of bye-laws in one or more local newspapers for at least one month before making the application; meanwhile a copy of the proposed

bye-laws must be kept at the office of the L.A., accessible to the ratepayers during office hours.

The penalty imposed under bye-laws is limited to five pounds for each offence, and not more than forty shillings a day for its continuance.

Regulations are less formal than bye-laws, and do not require the assent of the L.G.B. except in certain cases in which a penalty is provided—*e.g.*, the regulations made under sec. 125 of the P.H.A., 1875.

All that is necessary is that they shall be passed at a regular meeting of the L.A., and there is no publication legally needed.

Bye-laws may be made under the Public Health Act for a large number of objects, and, for some purposes, the L.G.B. has issued model codes which are often adopted in their entirety by the L.A. The principal Model Bye-laws are issued in an annotated form by Messrs. Knight, with notes by Mr. W. A. Casson, and are well worth perusal by the officers of Local Authorities. The valuable remarks prefixed to some of them—*e.g.*, common lodging-houses and slaughter-houses—have already been noticed.

Bye-laws are made as follows for the objects enumerated :—

Public Health Act, 1875.

1. The cleansing of footways, etc. ; the removal of house refuse from premises ; and the cleansing of privies, etc.
2. The prevention of nuisances arising from snow, filth, etc.
3. The improper keeping of animals.

All these powers are contained in sec. 44 Model Bye-laws, I. and II.

4. Sec. 80.—For the government of common lodging-houses, Model Bye-laws, III.
5. Sec. 90.—For houses let in lodgings. As amended by sec. 8 of the H.W.C. Act, 1885. Model Bye-laws, XIII.
6. Sec. 113.—Offensive trades. Model Bye-laws, XVI.
7. Sec. 141.—Public mortuaries. Model Bye-laws, XV.
8. Sec. 157.—New streets and buildings. Model Bye-laws, IV.

In connection with this section must be considered the powers, given under sec. 23 of the P.H.A.A., 1907, where it has been adopted, to make additional bye-laws for both urban and rural districts. No Model Bye-laws have been issued under these clauses, but the models issued by Knight & Co., for which Mr.

Casson is mainly responsible, are regarded as models and accepted by the L.G.B.

9. Sec. 164.—Public walks, etc.

10. Sec. 167.—Markets (see the Markets and Fairs Clauses Act, 1847, sec. 42). Model Bye-laws, V.

11. Hackney carriages (Model Bye-laws, VII.), and Public Bathing (Model Bye-laws, VIII.).

12. Sec. 172.—Horses, etc., for hire. Model Bye-laws, XI. Pleasure boats. Model Bye-laws, XII.

13. Sec. 314.—Hop-pickers. Model Bye-laws. See also Fruit Pickers Act, 1882. Model Bye-laws.

All these, except as stated with respect to the rural bye-laws for buildings, are limited to urban authorities. Otherwise, rural authorities have powers to make bye-laws only for (1) private scavenging, (2) common lodging-houses, (3) hop-pickers and fruit pickers, (4) tents and vans, and (5) mortuaries.

Regulations may be made under secs. 21, 125, 143, 189, and 200 of the Public Health Act, 1875, and under secs. 20, 40, and others of the P.H.A.A., 1890, but the reader is referred to the clauses which have already been discussed.

It is perhaps necessary to remind the inspector that, in taking any proceedings under bye-laws, it is better to set out the bye-law in full to the defendant, and to produce a copy of the same for the use of the bench if the case goes before a Court.

The Sanitary Law of the Metropolis.

The Act of 1891 was intended to do for London what the Act of 1875 had done for the rest of the districts of England and Wales. Up to that time London had been governed by a large number of miscellaneous Acts, commencing with the Metropolis Management Act of 1855; the sanitary authorities had been a mixed body of vestries, boards of works, and the City of London; the Local Government Act had created the County Council and had given to it a certain control over the sanitary authorities, with the exception of the City of London which in certain matters retained its ancient rights and privileges. Later on the municipalisation of London was effected by the London Government Act of 1899, under which the sanitary authorities are now the Common Council for the City of London and the Metropolitan Borough Councils (Woolwich included).

The relations between the London County Council and the

various London Boroughs do not here concern us, but it may suffice to say that the powers conferred upon the L.C.C. to make bye-laws and in other ways to enforce their pleasure upon the boroughs have not been exercised without friction, and that the administration of some details are still contentious matters.

The L.C.C. have power to make bye-laws applying to the whole of the Metropolis for many purposes and to compel the sanitary authorities to enforce them (except in the City); by sec. 16 of the London Act the L.C.C. may make bye-laws for the removal of fæcal matter, for the filling up of cesspools and privies, and further on in the Act for the removal and disposal of refuse and for the better regulation of offensive trades.

The L.C.C. have also power to act in default of any sanitary authority in London (except the City), and as in the case of County Councils throughout the kingdom, they must receive an annual report from each sanitary authority, including a report from the M.O.H.

The sections which deal with ordinary nuisances do not need comment as the provisions are very similar to those in the Act of 1875 with few exceptions; it now becomes the statutory duty of the inspector to serve the preliminary notice calling attention to the nuisance; the subsequent statutory notice need not now contain specified instructions as to the work required to be done; it is, however, within the discretion of the court to define the works requisite or not as they please in making an order.

The power given to constables to seize and detain any stray pig may give rise to humorous comment, as it is by no means clear what he is to do with it when he has got it.

It may be remarked that refuse destructors and similar places for refuse disposal—*e.g.*, sorting yards and the like—are specially included among offensive trades, and that even where they belong to a sanitary authority it would be within the power of the L.C.C. to take proceedings against them in case of nuisance. The Acts relating to smoke nuisances are consolidated in this Act.

With regard to the provision of sanitary conveniences, the sanitary authority may require a new house to be provided with as many water-closets as they may deem necessary, and by sub-sec. 4 of the section (37) privies are now wholly forbidden except where there is no sewerage or sufficient water supply. In regard to the provision of public conveniences the subsoil of every road is now made to vest in the sanitary authority;

the importance of this provision as the running of underground pipes, etc., is considerable, although no case seems to have arisen under the section.

The powers with regard to unsound food are extended so as to cover all articles intended for the food of man, as in the provinces under the amended Acts. One important point may be noticed: by sec. 47, sub-sec. 8, any person having in his possession food unsound and unfit for the food of man may inform the sanitary authority and request its removal as trade refuse.

The law relating to infectious disease contains a provision for sending information of cases notified to the head teachers of schools, a proceeding which in some form or another prevails very largely in the provinces, and which is likely to be more prevalent since the schools are under the control of the L.A.

Attention may be called to the compulsory provision of mortuaries and to the very strict rules laid down with regard to cellar dwellings, and to the liability of poor law guardians for the charges of those admitted to the infectious hospitals.

Beyond these special notes the London Act contains in the main similar provisions to those of the Public Health Act, 1875, incorporating therewith most of the useful and applicable provisions contained in the amending Acts.

Sanitary Law in Scotland.

The law of public health in Scotland is the most recent code in the three kingdoms, being the Act of 1897. Without entering fully into all the details of this Act it will be of some interest to the student to point out a few of the cases in which it differs from similar enactments in England and Wales.

The sanitary authorities are counties (excluding burgh representatives), burghs, and districts; the officers are as elsewhere, the medical officer of health having fixity of tenure.

Under the head of definitions the word "premises" receives a very extended significance, and the term "owner" is more clearly defined than under the English law; and with regard to nuisances there is a convenient term the "author of a nuisance" —*i.e.*, the person by whose act or default the nuisance arises, exists, or is continued.

The nuisance clause is extended to cover a very wide area: water dangerous or injurious to health; animals kept in a byre

or stable in such numbers as to be injurious to health ; accumu lations of mineral rubbish near a public road, or offensive matter in trucks, sidings, or on canals (except manure in farmyards and spent hops) ; offensive trades (including specially rag and bone yards) ; and overcrowded, badly situated or managed cemeteries and churchyards are all nuisances within the meaning of sec. 16.

The preliminary notice alluded to in English practice and directly authorised by the London Act is here again authorised, and is called an "intimation." When subsequently the statutory notice comes to be served it is not necessary here any more than in London to specify the works required to be carried out.

All slaughter-house licences in Scotland are now annual, and may be refused on the appointed day in each year without compensation, the only appeal being to the L.G.B. of Scotland. Under the Burgh Police Act a report on the condition of every slaughter-house in the district must be presented to the L.A. twice in each year.

In questions of meat seizure a veterinary surgeon is associated with the M.O.H. and the inspector, and he may exercise the same powers as they may. In the case of the seizure of a live animal, which is here statutory, and does not merely rest on a decision, his presence is essential to the proper seizure. The post-mortem examination of animals is provided for, and an extended power is given to the L.A. to appoint a veterinary surgeon for all the purposes of the Act. The enactment relating to food and drugs is common to the three kingdoms.

In the matter of infectious disease, notification is compulsory also in Scotland, and the powers for the prevention of disease are an extended re-enactment of the principal clauses of the Infectious Diseases Prevention Act ; clauses exist for the prevention of infected children attending school, for removing the inmates of a house before disinfection, and for other purposes.

In the definition of a common lodging-house we find a new meaning :—" A common lodging-house is a house or part thereof where lodgers are housed at an amount not exceeding 4d. per night, or such other sum as shall be fixed under the provisions of the Act (by sec. 89 this cannot exceed 6d.), for each person, whether the same be payable nightly or weekly, or for any period not longer than a fortnight, and shall include any place where emigrants are lodged, and all boarding-houses for seamen, irrespective of the amount charged for lodging or board."

The directions to inspectors and the Model Bye-laws of the

Scotch L.G.B. are well worth perusal by every student of sanitary administration.

In addition to the above Act, the Scotch student will do well to refer to the Burgh Police (Scotland) Acts of 1892 and 1903, which contain a large number of sanitary provisions for cleansing, ruinous buildings, water supply, slaughter-houses, drainage, water-closets, etc.

Sanitary Law in Ireland.

The sister kingdom, like England and Wales, is still awaiting a codification of the Acts relating to Public Health. In 1878 the Public Health (Ireland) Act as drafted on the lines of the Act of 1875, and, like that Act, has been amended and tinkered in many places.

The Irish sanitary authorities are, as in England, urban and rural, and are constituted on the one hand by the Town Councils (about twelve in number) and by the Municipal Commissioners (about sixty), and on the other by the various Boards of Guardians of the Poor.

Unfortunately, no provision was made in the Act for investing rural districts with urban powers, so that a large number of towns of considerable size are still under the imperfect government of rural authorities, although the L.G.B. for Ireland have power by provisional order to create new urban districts.

It is quite beyond the scope of a work intended for sanitary inspectors in this country to discuss the provisions of this Act—the provisions as to nuisances and the duties of the inspector with regard to them are much the same, and if the standard of sanitary progress is not quite so high as in other parts of the kingdom, the need for the careful administration of the powers provided will but be greater.

The following books will be found useful by students of sanitary law, and contain in greater detail the provisions which have been reduced to the very smallest compass, compatible with usefulness :—

Knight's cheap edition of the Public Health Statutes.

"Knight's Annotated Model Bye-laws." Edited by W. A. Casson.

"Lumley's Public Health." Edited by MacMorran and Lushington.

"The Law of Public Health." Edited by Glen and Jenkins.

"Sanitary Law and Practice." By Robertson and Porter.

"Lectures on Sanitary Law." By Professor Wynter Blyth.

"Treatise on Hygiene and Public Health." By Stevenson and Murphy. Vol. III. relating to Sanitary Law.

"The Public Health (London) Act." Edited by MacMorran.

"Factories and Workshops." By Abraham and Davies.

"Sale of Food and Drugs Acts." Edited by Hedderwick.

"Knight's Model Bye-Laws under the Public Health Acts Amendment Act, 1890." Edited by W. A. Casson.

"Handbook of Scotch Sanitary Law." By T. W. Swanson.

"The Law relating to the Pollution of Rivers and Streams." By J. Vesey Fitzgerald.

Most of these volumes are of an expensive character, and, with the exception of the Public Health Statutes, are not necessary to the ordinary student, except as books of reference; he would also do well to familiarise himself with the Model Bye-laws, though the annotated edition is not absolutely necessary, and only contains some of those issued by the L.G.B.

Home Office, *November*, 1914.

Annual Report of Medical Officer of Health for Year for the of*

* *e.g.*, Metropolitan Borough, County Borough Borough, Urban District, Rural District.

FACTORIES, WORKSHOPS, LAUNDRIES, WORKPLACES & HOMEWORK.

1.—INSPECTION.

INCLUDING INSPECTIONS MADE BY SANITARY INSPECTORS OR INSPECTORS OF NUISANCES.

Premises.	Number of		
	Inspections.	Written Notices.	Prosecutions.
Factories, ... (Including Factory Laundries.)			
Workshops, ... (Including Workshop Laundries.)			
Workplaces, ...			
Homeworkers' Premises, ..			
Total, ...			

2.—DEFECTS FOUND.

Particulars.	Number of Defects.			Number of Prosecutions.
	Found.	Remedied.	Referred to H.M. Inspector.	
*Nuisances under the Public Health Acts:—**				
Want of cleanliness, ...				
Want of ventilation, ...				
Overcrowding, ...				
Want of drainage of floors, ...				
Other nuisances, ...				
Sanitary accommodation: insufficient, ..				
Sanitary accommodation: unsuitable or defective. ..				
Sanitary accommodation: not separate for sexes, ..				
Offences under the Factory and Workshop Act:—				
Illegal occupation of underground bakehouse (S. 101), ...				
Breach of special sanitary requirements for bakehouses (97 to 100), ...				
Other offences (excluding offences relating to outwork which are included in Part 3 of this Report), ...				
Total, ...				

* Including those specified in Sections 2, 3, 7, and 8 of the Factory and Workshop Act, 1901, as remediable under the Public Health Acts.

Part 3 relates to **HOME WORK,** and provision is made in a table for the following particulars being given relating to a number of specific occupations, the particulars being as follows:—

List of outworkers received from employers. Sec. 107.	Twice a year.	Contractors,	....
		Workmen,	....
	Once a year.	Contractors,	....
		Workmen,	....
Notices served on occupiers as to keeping or sending lists.			....
Prosecutions.	Failing to keep or permit inspection of lists,		....
	Failing to send lists,		....
Outworkers in unwholesome premises. Sec. 108.	Instances,		....
	Notices served,		....
	Prosecutions,		....
Outwork in infected premises. Secs. 109 and 110.	Instances,		....
	Orders made (Sec. 110),		....
	Prosecutions (Secs. 109 and 110),		....

4.—REGISTERED WORKSHOPS.

Workshops on the Register (S. 131) at the end of the year. (1).	Number. (2).
Important classes of workshops, such as workshop bakehouses, may be enumerated here.	
Total number of workshops on Register, ..	

5.—OTHER MATTERS.

Class. (1).		Number. (2).
Matters notified to H.M. Inspector of Factories:—		
Failure to affix Abstract of the Factory and Workshop Acts (S. 133, 1901), ...		
Action taken in matters referred by H.M. Inspector as remediable under the Public Health Acts, but not under the Factory and Workshop Acts (S. 5, 1901).	Notified by H.M. Inspector,	
	Reports (of action taken) sent to H.M. Inspectors,	
Other, ...		
Underground bakehouses (S. 101) in use at the end of the year, ...		

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